Performance Management

Study Text

The Institute of Chartered Accountants of Nigeria

ICAN

Performance management

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Foreword

The business environment has been undergoing rapid changes caused, by globalisation and advancement in Information Technology. The impact of these changes on the finance function and the skills set needed by professional accountants to perform their various tasks have been profound. These developments have made it inevitable for the Institute's syllabus and training curriculum to be reviewed to align its contents with current trends and future needs of users of accounting services.

The Institute of Chartered Accountants of Nigeria (ICAN) reviews its syllabus and training curriculum every three years, however, the syllabus is updated annually to take cognisance of new developments in the national environment and the global accountancy profession. The Syllabus Review, Professional Examination and Students' Affairs Committees worked assiduously to produce a 3-level, 15-subject ICAN syllabus. As approved by the Council, examinations under the new syllabus will commence with the November 2021 diet.

It is instructive to note that the last four syllabus review exercises were accompanied with the publication of Study Texts. Indeed, when the first four editions of Study Texts were produced, the performances of professional examination candidates significantly improved. In an effort to consolidate on these gains and to further enhance the success rates of students in its qualifying examinations, the Council approved that a new set of learning materials (Study Texts) be developed for each of the subjects. Although, these learning materials may be regarded as the fifth edition, they have been updated to include IT and soft skills in relevant subjects, thereby improving the contents, innovation, and quality.

Ten of the new learning materials were originally contracted to Emile Woolf International (EWI), UK. However, these materials were reviewed and updated to take care of new developments and introduced IT and soft skills in relevant subjects. Also, renowned writers and reviewers which comprised eminent scholars and practitioners with tremendous experiences in their areas of specialisation, were sourced locally to develop learning materials for five of the subjects because of their local contents. The 15 subjects are as follows:

Foundation Level		
1.	Business, Management and Finance	EWI/ICAN
2.	Financial Accounting	EWI/ICAN
3.	Management Information	EWI/ICAN
4.	Business Law	ICAN

Skills Level		
5	Financial Reporting	EWI/ICAN
6	Audit and Assurance	EWI/ICAN
7.	Taxation	ICAN
8.	Corporate Strategic Management and Ethics	EWI/ICAN
9.	Performance Management	EWI/ICAN
10.	Public Sector Accounting and Finance	ICAN

Professional Level		
11.	Corporate Reporting	EWI/ICAN
12.	Advanced Audit and Assurance	EWI/ICAN
13.	Strategic Financial Management	EWI/ICAN
14.	Advanced Taxation	ICAN
15.	Case Study	ICAN

As part of the quality control measures, the output of the writers and reviewers were subjected to further comprehensive review by the Study Texts Review Committee.

Although the Study Texts were specially produced to assist candidates preparing for the Institute's Professional Examination, we are persuaded that students of other professional bodies and tertiary institutions will find them very useful in the course of their studies.

Haruna Nma Yahaya (Mallam), mni, BSc, MBA, MNIM, FCA
Chairman, Study Texts Review Committee

A

Acknowledgement

The Institute is deeply indebted to the underlisted locally-sourced rewriters, reviewers and members of the editorial board for their scholarship and erudition which led to the successful production of these new study texts. They are:

Taxation		
1.	Enigbokan, Richard Olufemi	Reviewer
2.	Clever, Anthony Obinna	Writer
3.	Kajola, Sunday Olugboyega	Writer

Business Law		
1.	Oladele, Olayiwola.O	Writer/Reviewer
2.	Adekanola, Joel .O	Writer

Public Sector Accounting and Finance		
1.	Osho, Bolaji	Writer/Reviewer
1.	Biodun, Jimoh	Reviewer
2.	Osonuga, Timothy	Writer
3.	Ashogbon, Bode	Writer

Advanced Taxation		
1.	Adejuwon, Jonathan Adegboyega	Reviewer
2.	Kareem, Kamilu	Writer

Information Technology Skills		
1.	Ezeilo, Greg	Reviewer
2.	Ezeribe, Chimenka	Writer
3.	Ikpehai, Martins	Writer

Case Study		
1.	Adesina, Julius Babatunde	Writer/Reviewer

Soft Skills		
1.	Adesina, Julius Babatunde	Reviewer
2.	Adepate, Olutoyin Adeagbo	Writer

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Business Management and **Finance**	
1.	Ogunniyi, Olajumoke

Management Information	
1.	Adesina, Julius Babatunde
2.	Ezeribe, Chimenka

Financial Accounting	
1.	Adeyemi, Semiu Babatunde

Financial Reporting	
1.	Okwuosa, Innocent

Performance Management	
1.	Durukwaku, Sylvester

Corporate Strategic Management and **Ethics**	
1.	Adepate, Olutoyin Adeagbo

Audit & Assurance	
1.	Amadi, Nathaniel

Corporate Reporting	
1.	Adeadebayo, Shuaib

Advanced Audit and **Assurance**	
1.	Okere, Onyinye

Strategic Financial Management	
1.	Omolehinwa, Ademola

The Institute also appreciates the services of the following:

STUDY TEXTS REVIEW COMMITTEE

Members	
Haruna Nma Yahaya (Mallam), mni, BSc, MBA, ANIM, FCA	Chairman
Okwuosa, Innocent, PhD, FCA	Adviser
Akinsulire, O. O. (Chief), B.Sc, M.Sc., MBA, FCA	Deputy Chairman
Adesina, Julius, B. B.Sc, M.Sc, MBA,FCA	Member
Adepate, Olutoyin, B.Sc, MBA, FCA	Member
Enigbokan, Richard Olufemi, PhD, FCA	Member
Anyalenkeya, Benedict, B.Sc, MBA, FCA	Member (Deceased)

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Kumshe, Ahmed Modu, (Prof.), FCA	Registrar/Chief Executive
Momoh, Ikhiegbia B., MBA, FCA	Director, Examinations
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Anifowose, Isaac, B.Sc., MMP	Manager, Students' Affairs
Evbuomwan, Yewande, B.Sc. (Ed.), M.Ed., ACIS	Asst. Manager, Students' Affairs

Ahmed M. Kumshe, (Prof.), FCA
Registrar/Chief Executive

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Contents

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S

Syllabus

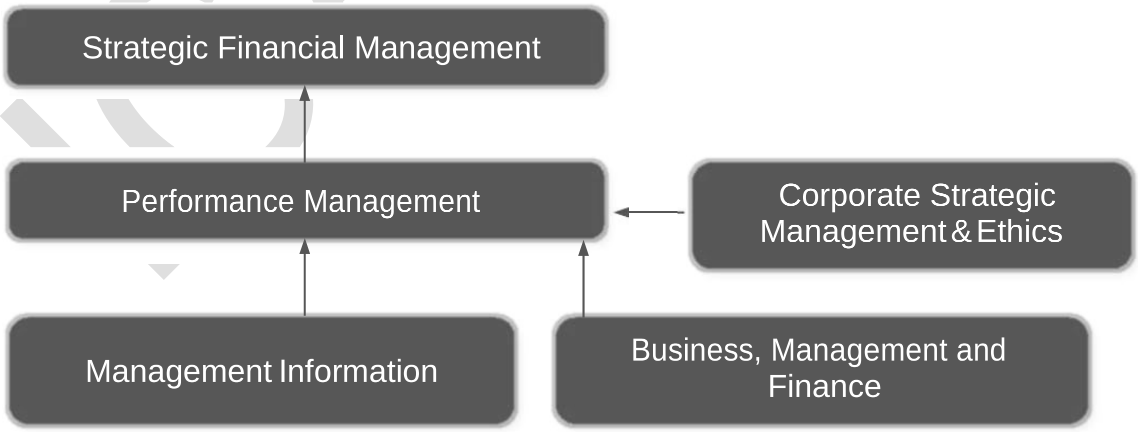
SKILLS LEVEL

PERFORMANCE MANAGEMENT

Aim
Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Linkage with other subjects

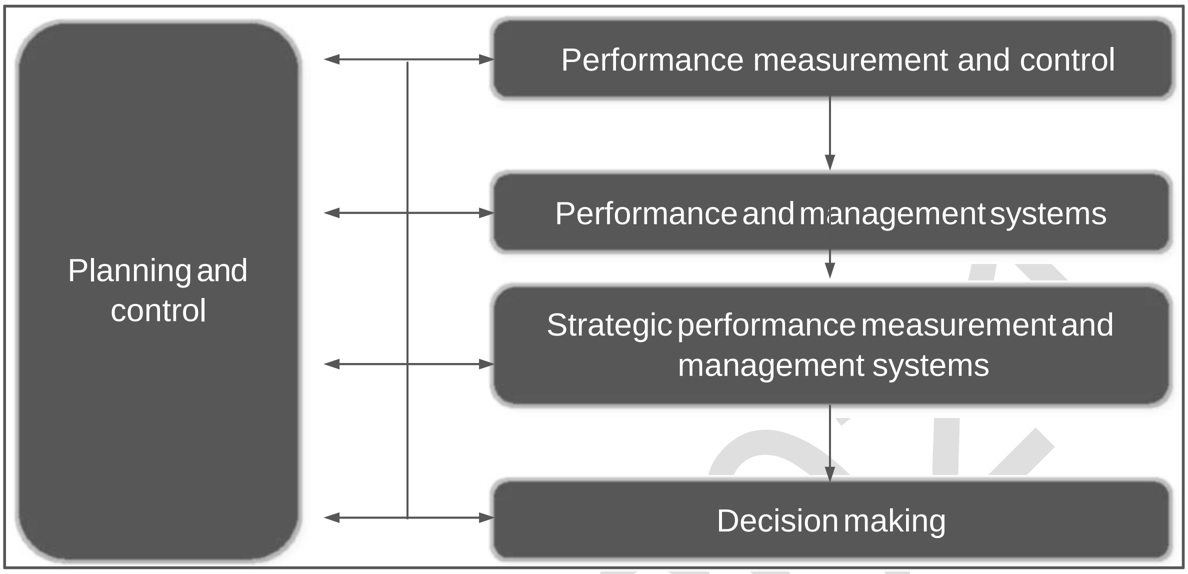
The diagram below depicts the relationship between this subject and other subjects.



Main competencies	
On successful completion of this paper, candidates should be able to:	
	Identify and apply appropriate budgeting techniques and standard costing to planning and control in business;
	Select and apply performance measurement techniques;
	Apply strategic performance measurement techniques in evaluating and improving organizational performance;
	Discuss the accounting information requirements and the role of accountants in project management; and
	Select and apply decision-making techniques to facilitate efficient and effective business decisions in the use of scarce resources.

Linkage of the main competencies

This diagram illustrates the linkage between the main competencies of this subject and is to assist candidates in studying for the examination.



Syllabus overview		
Grid		**Weighting**
A	Cost planning and control	20
B	Planning and control	20
C	Performance measurement and control	20
D	Decision making	30
E	Strategic performance measurement	5
F	Performance and management system	5
Total		**100**

Detailed syllabus					Chapter
A	**Cost planning and control**				
	1	**Overview of costs for planning and control**			
		a	Discuss and evaluate the sources of performance management information.		2
		b	Analyse fixed and variable cost elements from total cost data using high/low method and regression analysis.		2
		c	Differentiate between marginal costing and absorption costing.		2
		d	Analyse overhead costs using activity based costing.		2
	2	**Cost planning and control for competitive advantage**			
		a	Discuss and apply the principles of:		3
			i	Target costing;	3
			ii	Life cycle costing;	3
			iii	Theory of constraints (TOC);	3
			iv	Throughput accounting;	3
			v	Back flush accounting;	3
			vi	Environmental accounting; and	3
			vii	Kaizen costing.	3
		b	Learning and experience curve theory		4
			i	Discuss and apply the learning and experience curve theory to pricing, budgeting and other relevant problems.	4
			ii	Calculate and apply learning rate to cost estimation.	4
		c	Cost of quality		5
			i	Explain quality costs.	5
			ii	Analyse quality costs into costs of conformance and costs of non-conformance.	5
			iii	Discuss the significance of quality costs for organisations.	5
	3	**Ethical issues in performance management**			
		a	Discuss ethical issues in performance management.		2
		b	Discuss the professional accountants' code of ethics as it relates to performance management.		2

Detailed syllabus					Chapter
B	**Planning and control**				
	1	**Budgetary system, planning and control**			
		a	Discuss and apply forecasting techniques to planning and control.		6
		b	Discuss budgetary system in an organization as an aid to performance management.		6
		c	Evaluate the information used in budgetary system.		6
		d	Discuss the behavioural aspects of budgeting.		6
		e	Discuss the usefulness and problems associated with different types of budget.		6
		f	Explain ***beyond budgeting*** models.		6
	2	**Variance analysis**			
		a	Explain the uses of standard cost and types of standard.		7
		b	Discuss the methods used to derive standard cost.		7
		c	Explain and analyse the principle of controllability in the performance management system.		
		d	Calculate and apply the following variances:		7, 8
			i	Material usage and price variances;	7
			ii	Material mix and yield variances;	8
			iii	Labour rate, efficiency and idle time variances;	7
			iv	Variable overhead expenditure and efficiency variances;	7
			v	Fixed overhead budget, volume, capacity and productivity variances;	7
			vi	Sales volume variance;	7
			vii	Sales mix and quantity variances;	8
			viii	Sales market size and market share variances; and	8
			ix	Planning and operational variances.	8
		e	Identify and explain causes of various variances and their inter-relationship.		7, 8
		f	Analyse and reconcile variances using absorption and marginal costing techniques		7, 8

Detailed syllabus				Chapter
C	**Performance measurement and control**			
	1	**Performance analysis**		
		a	Select and calculate suitable financial performance measures for a business from a given data and information.	9
		b	Evaluate the results of calculated financial performance measures based on business objectives and advise management on appropriate actions.	9
		c	Select and calculate suitable non-financial performance measures for a business from a given data and information.	9
		d	Evaluate the results of calculated non-financial performance measures based on business objectives and advise management on appropriate actions.	9
		e	Explain the causes and problems created by short-termism and financial manipulation of results and suggest methods to encourage a long term view.	9
		f	Discuss sustainability consideration in performance measurement of a business.	9
		g	Select and explain stakeholders based measures of performance that may be used to evaluate social and environmental performance of a business.	9
		h	Explain and interpret the Balanced Scorecard and Fitzgerald and Moon Building Block model.	9
	2	**Performance analysis in not-for-profit organisations**		
		a	Discuss the problems of having non-quantifiable objectives in performance management.	10
		b	Explain how performance may be measured in the not-for-profit organisations.	10
		c	Discuss the problems of having multiple objectives.	10
		d	Demonstrate value for money (VFM) as a public sector objective.	10
	3	**Divisional performance and transfer pricing**		**10, 11**
		a	Discuss the various methods of setting transfer prices and evaluate the suitability of each method.	10
		b	Determine the optimal transfer price using appropriate models.	10
		c	Explain the benefits and limitations of transfer pricing methods.	10
		d	Demonstrate and explain the impact of taxation and repatriation of funds on international transfer pricing.	10
		e	Select and explain suitable divisional performance measures for a given business using return on investment, residual income and economic value added approaches. Evaluate the results and advise management.	12

Detailed syllabus					Chapter
D	**Decision making**				
	1	**Advanced decision-making and decision-support**			
		a	Select and calculate suitable relevant cost based on given data and information. Evaluate the results and advise management.		13
		b	Select, calculate and present cost-volume-profit analyses based on a given data and information (including single and multiple products) using both numerical and graphical techniques. Advise management based on the results.		14
		c	Apply relevant cost concept to short term management decisions including make or buy, outsourcing, shut down, one-off contracts, adding a new product line, sell or process further, product and segment profitability analysis, etc.		18
		d	Apply key limiting factors in a given business scenario to:		
			i	Single constraint situation including make or buy; and	15
			ii	Multiple constraint situations involving linear programming using simultaneous equations, graphical techniques and simplex method. (The simplex method is limited to formulation of initial tableau and interpretation of final tableau).	16, 17
				NB. Computation and interpretation of shadow prices are also required.	17
		e	Explain different pricing strategies, including:		19
			i	Cost-plus;	19
			ii	Skimming;	19
			iii	Market penetration;	19
			iv	Complementary product;	19
			v	Product-line;	19
			vi	Volume discounting; and	19
			vii	Market discrimination.	19
		f	Calculate and present numerically and graphically the optimum selling price for a product or service using given data and information by applying relevant cost and economic models and advise management.		19
		g	Evaluate how management can deal with uncertainty in decision-making including the use of simulation, decision-trees, replacement theory, expected values, sensitivity analysis and value of perfect and imperfect information.		20, 27

Detailed syllabus						Chapter
D	**Decision making (continued)**					
	2	**Working capital management**				
		a	Discuss the nature, elements and importance of working capital.			21 to 24
		b	Calculate and explain the cash operating cycle.			21
		c	Evaluate and discuss the use of relevant techniques in managing working capital in relation to:			
			i	Inventory (including economic order quantity model and Just-in-Time techniques);		22
			ii	Account receivables (including cash discounts, factoring and invoice discounting);		23
			iii	Account payables; and		23
			iv	Cash (including Baumol and Miller-Orr Models).		24
	3	**Capital budgeting decisions**				
		a	Discuss the characteristics of capital budgeting decisions.			25
		b	Calculate and discuss various investment appraisal techniques such as:			
			i	Traditional techniques		25
				•	Accounting rate of return	25
				•	Pay-back period	25
			ii	Discounted cash flow technique		26
				•	Net Present Value	26
				•	Internal Rate of Return	26
					NB: These may Include basic profitability index and inflation but excluding tax consideration and capital rationing.	26
		c	Evaluate asset replacement decision for mutually exclusive projects with unequal lives.			27

Detailed syllabus				Chapter
E	**Strategic performance measurement**			
	1	Analyse and evaluate business objectives and strategies using techniques such as:		**28**
		a	C-analysis;	28
		b	Five forces analysis;	28
		c	The Boston Consulting Group Model;	28
		d	Value chain analysis;	28
		e	Ansoff's matrix;	28
		f	Benchmarking; and	28
		g	SWOT analysis.	28
	2	Analyse and evaluate suitable performance measures for:		
		a	Profitability (GP, ROCE, ROI, EPS, EBITDA, etc.);	9
		b	Liquidity; and	9
		c	Solvency.	9
F	**Performance and management systems**			
	1	Evaluate and advise management on suitable information technology and strategic performance management system covering:		**29**
		a	Sources of information;	29
		b	Information technology tools for performance management at various levels (strategic, tactical and operational); and	29
		c	Use of internet technologies for performance management and key performance indicators.	29
	2	Evaluate and advise management on suitable approaches that may be used to manage people, issues and change when implementing performance management systems.		30
	3	Discuss the accounting information requirements and analyse the different types of information systems used for strategic planning, management control and operational control and decision-making.		30
	4	Discuss roles of accountants in:		
		a	Project management;	30
		b	Project planning; and	30
		c	Project control methods and standards.	30

Skills level
Performance management

CHAPTER 1

Introduction to strategic management

Contents

INTRODUCTION

Purpose

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Exam context

This chapter does not address a specific syllabus competency. It has been written to explain the meaning of strategic planning to provide a foundation for understanding the above and other areas in the syllabus. In particular, it explains strategic objectives and the differing informational needs of management at different levels in an organisation.

By the end of this chapter, you should be able to:

- Explain the difference between strategic, tactical and operational planning and control
- Understand the strategic planning process in overview
- Explain the importance of corporate objectives and the link to performance management
- Explain the different informational needs for strategic, tactical and operational management
- Understand the potential conflict that may arise between strategic objectives and short-term decisions.

1 INTRODUCTION TO STRATEGIC PLANNING AND CONTROL

Section overview

- Management accounting
- Levels of strategic planning
- Definition of strategic planning and control
- Strategic planning process

1.1 Management accounting

The purpose of management accounting is to provide relevant and reliable information so that managers can make well-informed decisions. The value of management accounting depends on the quality of the information provided, and whether it helps managers to make better decisions.

In other words, the purpose of management accounting is to provide information for:

- planning;
- control; and
- decision making.

Performance management includes these three concepts:

Planning

Planning involves the following:

- setting the objectives for the organisation;
- making plans for achieving those objectives.

The planning process is a formal process and the end-result is a formal plan, authorised at an appropriate level in the management hierarchy. Formal plans include long-term business plans, budgets, sales plans, weekly production schedules, capital expenditure plans and so on.

Information is needed in order to make sensible plans – for example in order to prepare an annual budget, it is necessary to provide information about expected sales prices, sales quantities and costs, in the form of forecasts or estimates.

Control

Control of the performance of an organisation is an important management task. Control involves the following:

- monitoring actual performance, and comparing same with the objective or plan;
- taking control action where appropriate;
- evaluating actual performance.

When operations appear to be getting out of control, management should be alerted so that suitable measures can be taken to deal with the problem. Control information might be provided in the form of routine performance reports or as special warnings or alerts when something unusual has occurred.

Decision making

Managers might need to make 'one-off' decisions, outside the formal planning and control systems. Management accounting information can be provided to help a manager decide what to do in any situation where a decision is needed.

1.2 Levels of strategic planning

Planning is a hierarchical activity, linking strategic planning at the top with detailed operational planning at the bottom. Strategic plans set a framework and guidelines within which more detailed plans, and shorter-term planning decisions, can be made.

R. N. Anthony (1965) identified three levels of planning within an organisation:

- **Strategic planning**. This involves identifying the objectives of the entity, and plans for achieving those objectives, mostly over the longer term. Strategic plans include corporate strategic plans, business strategic plans and functional strategic plans.
- **Tactical planning**. These are shorter-term plans for achieving medium-term objectives. An example of tactical planning is the annual budget. Budgets and other tactical plans can be seen as steps towards the achievement of longer-term strategic objectives.
- **Operational planning**. This is a detailed planning of activities, often at a supervisory level or junior management level, for the achievement of short-term goals and targets. For example, a supervisor might divide the workload between several employees in order to complete all the work before the end of the day.

1.3 Definition of strategic planning and control

'Strategic planning and control' within an entity is the continuous process of:

- identifying the goals and objectives of the entity;
- planning strategies that will enable these goals and objectives to be achieved;
- setting targets for each strategic objective (performance targets);
- converting strategies into shorter-term operational plans;
- implementing the strategy;
- monitoring actual performance (performance measurement and review); and
- taking control measures where appropriate when actual performance is below the target.

Other aspects of strategic planning and control are:

- re-assessing plans and strategies when circumstances in the business environment change; and
- where necessary, changing strategies and plans.

Formal planning process

Companies might have a formal strategic planning process. Such a process:

- clarifies objectives;
- helps management to make strategic decisions. Strategic planning forces managers to think about the future: companies are unlikely to survive unless they plan ahead;
- establishes targets for achievement;
- co-ordinates objectives and targets throughout the organisation, from the mission statement and strategic objectives at the top of a hierarchy of objectives, down to operational targets;
- provides a system for checking progress towards the objectives.

However, planning must also be flexible. Plans and targets might need to change in response to changes in the business environment, for example, a new initiative by a rival company.

Changes in strategic plans

Strategic plans often cover a period of several years, typically five years or longer. They are prepared on the basis of the best information available at the time, using assumptions about the nature of the business environment – competitive conditions, market conditions, available technology, the economic, social and political climate, and so on.

However, the business environment can change very quickly, in unexpected ways. Changes can create new threats to a company, or they can create new business opportunities. Whenever changes occur, a company should be able to respond – by taking measures to deal with new threats, or to exploit new opportunities.

The response of a company to changes in its environment could mean having to develop new strategies and abandon old ones. When changes are made, the original strategic plan will no longer be entirely valid, although large parts of it might be unaffected.

Strategic planning in practice is therefore often a mixture of:

- formal planning, and
- developing new strategies and making new plans whenever significant changes occur in its business environment.

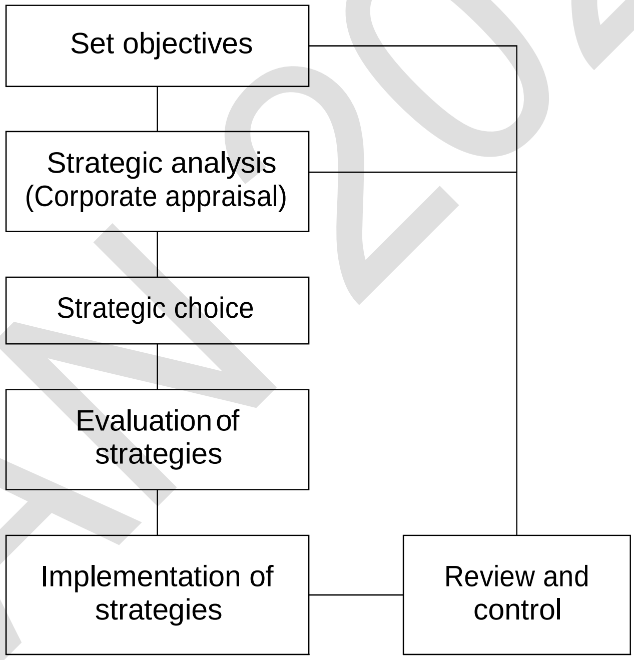
Responding to unexpected changes by doing something that is not in the formal plan is sometimes called ‘freewheeling opportunism’. It means making unplanned decisions, to take advantages of opportunities as they arise, or to deal with unexpected threats.

1.4 Strategic planning process

Different methods and approaches may be used to develop strategic plans but they share common features.

A basic approach to strategic planning is shown in the following diagram.

Illustration: Strategic planning process



Each stage will be explained in further detail later. For the moment, the text only provides an overview in order to provide a foundation for understanding key elements of performance management.

Objectives

The entity must develop clear objectives, such as, the maximisation of shareholders’ wealth. These objectives should be consistent with the mission statement. Targets can be established for the achievement of objectives within the planning period.

Objectives should take into account the interest and power of stakeholders. Stakeholder mapping is a useful tool in this regard.

Strategic analysis

A strategic analysis comprises:

- an environmental analysis; and
- a position audit.

Environmental analysis involves an analysis of developments outside the organisation that are already affecting the organisation or could affect the organisation in the future. These are external factors that might affect the achievement of objectives and strategy selection.

A position audit is an internal analysis which identifies the strengths and weaknesses within the organisation – its products, existing customers, management, employees, technical skills and 'know-how', its operational systems and procedures, its reputation for quality, the quality of its suppliers, its liquidity and cash flows, and so on.

The results of the environmental analysis and the position audit can be combined in a SWOT analysis. The SWOT analysis depicts the strengths and weaknesses of an organisation, and the opportunities and threats in its environment. This method of strategic analysis is often used by organisations as a starting point for strategic planning.

Strategic choice

Strategies should be developed to make full use of strengths within the entity and to reduce or remove significant weaknesses.

Strategies should be developed to:

- take advantage of opportunities;
- make full use of strengths;
- remove weaknesses; and
- take action to protect against threats.

These components of the strategic choice decisions will be covered later.

Evaluation of strategic options

Strategies should be evaluated to decide whether they might be appropriate. Johnson and Scholes have suggested that strategies should be assessed for:

- suitability;
- feasibility; and
- acceptability.

Strategic implementation

The selected strategies should then be implemented.

The implementation of strategies should be monitored. Changes and adjustments should be made where these become necessary.

Areas of importance here are change management and project management. These are covered in more detail later.

Review and control

This is a key area. An entity will have management information systems in place to monitor the progress of the business. These are particularly important to the introduction of a new strategy where timing and achievement of progress points might be vital to its success. This is covered in more detail later.

2 STRATEGIC OBJECTIVES

Section overview

- Planning and corporate objectives
- The need for performance measurement
- Management accounting and performance measurement

2.1 Planning and corporate objectives

The purpose of strategic planning and control is to help an entity to achieve its strategic objectives. It is normally assumed that the objective of a company is to provide a high return to its owners, the shareholders, consistent with the level of risk in the business.

Not-for-profit entities also have strategic objectives, which relate to the purpose for which they exist. These objectives are non-financial in nature.

Performance measurement is an integral part of a system of planning and control.

- **Planning targets clarify the objectives of the organisation**. Corporate objectives are converted into planning targets. Similarly, the objectives of strategic plans are converted into planning targets. A target should be a clear statement of what an entity wants to achieve within a specified period of time. Planning targets are usually quantified, but may be expressed in qualitative terms.
- **Measurements of performance** (target and actual) help to improve management's understanding of processes and systems.
- Planning targets are set at strategic, tactical and operational management levels. Using quantitative measures of performance makes it easier to set targets for managers and the organisation as a whole.
- In a well-designed performance management system, all planning targets are consistent with each other, at the strategic, tactical and operational levels.
- When the business environment is changing, a performance measurement system should provide for the continual re-assessment of planning targets, so that targets can be altered as necessary to meet the changing circumstances.
- Actual performance, at the strategic, tactical and operational levels should be measured and monitored. Comparing actual performance with targets provides useful control information. Differences between actual performance and targets can be analysed, to establish the causes. Where appropriate, action can be taken to improve performance by dealing with the causes of the poor performance.
- Performance measures also make it possible to compare the performance of different organisations or different divisions within the same organisation.
- Performance measurement systems promote accountability of the organisation to its stakeholders.
- A performance management system may be linked to a system of rewarding individuals for the successful achievement of planning targets.

2.2 The need for performance measurement

Every managed organisation needs a system of performance measurement.

- Managers need to understand what they should be trying to achieve. A sense of purpose and direction is provided by plans (strategies, budgets, operational plans and so on), and for each plan there should be objectives and targets. Setting targets for achievement (performance targets) is an essential part of planning.
- Managers also need to know whether they are successful. The information they need is provided by comparing:
    - their actual results or performance with the performance target, and
    - the performance target with the current forecast of what performance will be.

Targets, forecasts and actual performance should be measured, in order to compare them. Ideally measures of performance should be quantified values (financial or non-financial measures), because numerical measures of performance are easier to compare than non-quantified ('qualitative') measures.

The benefits of performance measurement systems

The advantages of having a formal system of performance measurement can be summarised as follows:

- A well-structured system of performance measurement clarifies the objectives of the organisation, and shows how departments, work groups and individuals within the organisation contribute to the achievement of those objectives.
- It establishes agreed measures of activity, based on key success factors.
- It helps to provide a better understanding of the processes within the organisation, and what each should be trying to achieve.
- It provides a system for comparing the performance of different organisations or departments.
- The system establishes performance targets for the organisation's managers, over a suitable time period for achievement.

2.3 Management accounting and performance measurement

Management accounting is an important element in performance measurement systems. Many performance targets are financial in nature, such as achieving targets for return on capital, profits and sales revenue and targets for keeping expenditure under control.

However, a performance measurement system uses a wide range of targets at the strategic, tactical and operational level. Many of these are non-financial targets, and not all targets are quantifiable.

Clearly, a comprehensive management accounting system should therefore provide information for setting targets and measuring actual performance at all levels. It should also provide non-financial information as well as financial information.

If a management accounting system cannot provide all this information to management, managers will have to rely on other information systems in addition to the management accounting system. An entity might then have several different information systems, which is probably inefficient and less effective than a fully co-ordinated management information system.

3 LEVELS OF MANAGEMENT

Section overview

- Levels of management
- Potential conflict between strategic plans and short-term decisions

3.1 Levels of management

In 'traditionally-structured' large organisations, there is a hierarchy of managers, from senior management down to junior managers and supervisors. The responsibilities of managers vary according to their position in the management hierarchy.

Even in small organisations, the nature of management activities can be analysed into different levels.

A common approach to analysing levels of management and management decision-making process is to identify three levels:

- strategic management;
- tactical management; and
- operational management.

Strategic management

Strategic management is concerned with:

- deciding on the objectives and strategies for the organisation;
- making or approving long-term plans for the achievement of strategic targets;
- monitoring actual results, to check whether these are in line with strategic targets;
- where appropriate, taking control action to bring actual performance back into line with strategic targets; and
- reviewing and amending strategies.

A strategy is a plan for the achievement of a long-term objective. The main objective of a profit-making entity may be to maximise the wealth of its owners. Several strategies are selected for the achievement of this main objective, and each individual strategy might have its own specific objective.

Strategic planning is often concerned with developing products and markets and for long-term investment. For example, a company seeking to increase its profits by 10% a year for the next five years might select the following strategies:

- Marketing strategy: to expand into markets in other countries (with specific countries selected as planning targets for each year of the plan)
- Innovation strategy: to invest in research and development (with a target to launch, say, two new products on the market each year for the next five years)
- Investment strategy: to invest in new technology (with a target, say, of replacing all existing equipment with new technology within the next five years).

Tactical management

Tactical management is associated with the efficient and effective use of an organisation's resources, and the control over expenditure. In a large organisation, tactical managers are the 'middle managers'.

Tactical management is concerned with implementation and control of medium-term plans, within the guidelines of the organisation's strategic plans. For example, budgeting and budgetary control are largely tactical management responsibilities.

Operational management

Operational management is the management of day-to-day operating activities. It is usually associated with operational managers and supervisors.

At an operational level, managers need to make sure on a day-to-day basis that they have the resources they need and that those resources are being used efficiently. It includes scheduling of operations and monitoring output, such as daily efficiency levels.

There is no clear dividing line between tactical management and operational management, but essentially the differences are a matter of detail. Tactical management may be concerned with the performance of an entire department during a one-week period, whereas operational management may be concerned with the activities of individuals or small work groups on a daily basis.

3.2 Potential conflict between strategic plans and short-term decisions

Problems may occur in any organisation,especially large organisations with a large number of managers, when 'local' operational managers take decisions that are inconsistent with long-term strategic objectives.

There are several reasons why this might happen.

- 'Local' managers might be rewarded for achieving short-term planning targets, such as keeping actual expenditure within the budget limit. However, although there is a short-term benefit, there might be longer-term damage. For example, a local manager might decide to cut the training budget for his staff in order to reduce costs, but in the long-term the future success of the company might depend on having well-trained and skilled employees.
- 'Local' managers might fail to buy into the plan because they believe it to be unfair.
- 'Local' managers might be unaware of the strategic plans and objectives, due to poor communication within the entity.

In any system of performance management, especially in systems where managers are rewarded for achieving planning targets, it is important to make sure that the short-term planning targets are consistent with longer-term strategic objectives.

4 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the difference between strategic, tactical and operational planning and control
- Understand the strategic planning process in overview
- Explain the importance of corporate objectives and the link to performance management
- Explain the different informational needs for strategic, tactical and operational management
- Understand the potential conflict that may arise between strategic objectives and short-term decisions.

Skills level
Performance management

CHAPTER 2

Overview of cost planning and control

Contents

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

A	**Cost planning and control**		
	1	**Overview of costs for planning and control**	
		a	Discuss and evaluate the sources of performance management information.
		b	Analyse fixed and variable cost elements from total cost data using high/low method and regression analysis.
		c	Differentiate between marginal costing and absorption costing.
		d	Analyse overhead costs using activity based costing.

	3	**Ethical issues in performance management**	
		a	Discuss ethical issues in performance management.
		b	Discuss the professional accountants' code of ethics as it relates to performance management.

Exam context

You will have covered much of the content of this chapter in your earlier studies. A full explanation has been included here for your convenience.

By the end of this chapter, you should be able to:

- Calculate fixed and variable costs by using high-low points method
- Calculate fixed and variable costs by using regression analysis
- Calculate profit using total absorption costing and marginal costing and explain the difference
- Explain the difference between traditional volume based absorption methods and activity based costing
- Apportion overheads using activity based costing
- Estimate unit cost using activity based costing
- Discuss ethical issues in performance management and compliance with ICAN's code of ethics

1 PERFORMANCE MANAGEMENT INFORMATION

Section overview

- Business information
- Information for different management levels

1.1 Business information

Information is processed data. Data can be defined as facts that have not been assembled into a meaningful structure. Data is processed into a structured form that has some meaning: this is called 'information'.

Businesses use information in several ways.

- Information is used to perform routine transactions, such as order processing and invoicing.
- Information is used to make decisions.
- Information is also developed into knowledge that can be used to improve the business.

Managers could not make decisions without information. However, information can vary in quality, and as a general rule managers will make better decisions when they have better-quality information.

Information and management decisions

Decisions are taken continually in business. Routine decisions may be taken by any employee as a part of normal procedures. However, a specific role of management is to make decisions. For this, managers need information.

Managers use information:

- to make plans and reach planning decisions;
- to measure performance, and take control action on the basis of comparing actual or expected performance with a target;
- to make 'one-off' or non-routine decisions;
- to communicate decisions to other people; and
- to co-ordinate activities with other people.

1.2 Information for different management levels

Information should be provided to managers to help them to make decisions. The nature of the information required varies according to the level of management and the type of decision. Within organisations, there are management information systems that provide this information. A major element of the overall management information system should be the management accounting system.

A management accounting system should provide information for strategic management, tactical management and operational management.

The requirements of management for information vary with the level of management. This concept is set out simply in the diagram below.

Levels of management and information requirements

Strategic management information

Strategic management information is information that helps strategic managers to:

- make long-term plans;
- assess whether long-term planning targets will be met; and
- review existing strategies and make changes or improvements.

Strategic management needs strategic information. The characteristics of strategic information may be summarised as follows:

- It is often information about the organisation as a whole, or a large part of it.
- It is often in summary form, without too much detail.
- It is generally relevant to the longer-term.
- It is often forward-looking.
- The data that is analysed to provide the information comes from both internal and external sources (from sources inside and outside the organisation).
- It is often prepared on an 'ad hoc' basis, rather than in the form of regular and routine reports.
- It may contain information of a qualitative nature as well as quantified information.
- There is often a high degree of uncertainty in the information. This is particularly true when the information is forward-looking (for example, a forecast) over a number of years in the future.

Tactical information

Tactical information is information reported to middle managers in a large organisation, or for the purpose of annual planning and budgetary control.

Tactical information is used to decide how the resources of the organisation should be used, and to monitor how well they are being used. It is useful to relate tactical information to the sort of information that is contained in an annual budget. A budget is planning at a tactical management level, where the plan is expressed in financial terms.

The general features of tactical information are as follows:

- It is often information about individual departments and operations.
- It is often in summary form, but at a greater level of detail than strategic information.
- It is generally relevant to the short-term and medium-term.
- It may be forward-looking (for example, medium-term plans) but it is often concerned with performance measurement. Control information at a tactical level is often based on historical performance.
- The data that is analysed to provide the information comes from both internal and external sources (from sources inside and outside the organisation), but most of the information comes from internal sources.
- It is often prepared on a routine and regular basis (for example, monthly or weekly performance reports).
- It consists mainly of quantified information.
- There may be some degree of uncertainty in the information. However, as tactical plans are short-term or medium-term, the level of uncertainty is much less than for strategic information.

Control reports might typically be prepared every month, comparing actual results with the budget or target, and much of the information comes from internal sources. Examples of tactical information might be:

- variance reports in a budgetary control system;
- reports on resource efficiency, such as the productivity of employees;
- sales reports: reports on sales by product or by customer; and
- reports on capacity usage.

Operational information

Operational information is needed to enable supervisors and front line (operational) managers to organise and monitor operations, and to make on-the-spot decisions whenever operational problems arise. Operational information may also be needed by employees, to process transactions in the course of their regular work.

The general features of operational information are as follows:

- It is normally information about specific transactions, or specific jobs, tasks, daily work loads, individuals or work groups. (It is ‘task-specific’.)

- It may be summarised at a work group or section level, but is in a more detailed form than tactical information.
- It is generally relevant to the very short-term.
- It may be forward-looking (for example, daily plans) but it is often concerned with transactions, procedures and performance measurement at a daily level.
- The data that is analysed to provide the information comes almost exclusively from both internal sources (from sources inside the organisation).
- It consists mainly of quantified information. Most of this information is 'factual' and is not concerned with uncertainty.

Operational information is provided regularly, or is available online when required. It is concerned with operational details, such as:

- the number of employees in the department absent from work
- wastage rates in production
- whether the scheduled work load for the day has been completed
- delays and hold-ups in work flow, and the reasons for the delay
- whether a customer's order will be completed on time.

In many respects, strategic information, tactical information and operational information are all concerned with the same things – business plans and actual performance. They are provided in different amounts of detail and with differing frequency. However, with the development of IT systems and internal and external databases, it is possible for all levels of information to be available to managers online and on demand.

Example: Levels of information

An accountancy tuition company has a strategic target of increasing its annual sales.

What strategic, tactical and operational decisions might be taken towards achieving this target?

Here is a suggested answer.

(a) At a strategic level management may decide it is necessary to increase sales by 20%. It will then need to study the company and its business environment and decide how this might be done – for example by developing the existing business, buying a competitor company, or diversifying into other forms of training, such as training lawyers or bankers.

(b) At a tactical level, a budget should be prepared for the next year, based on strategic decisions already taken. Middle management should consider a variety of plans for achieving targets, such as spending more money on advertising, recruiting more trainers and running more training programmes. Targets might be set for each type of course or each geographical training centre location.

(c) Operational management will make decisions about the courses and their administration, such as making special offers (free study materials) to attract more students, running additional courses when demand is strong, and making sure that all student fees are collected.

2 SOURCES OF INFORMATION

Section overview

- Introduction
- Information from internal sources
- Information from external sources
- Costs of information
- Methods of gathering information

2.1 Introduction

Performance measurement systems, both for planning and for monitoring actual performance, rely on the provision of relevant, reliable and timely information. Information comes from both inside and outside the organisation.

Traditionally, management accounting systems have been an information system providing financial information to managers from sources within the organisation. In large organisations, management accounting information might be extracted from a cost accounting system, which records and analyses cost.

With the development of IT systems, management information systems have become more sophisticated, using large databases to hold data, from external sources as well as internal sources. Both financial and non-financial data are held and analysed. The analysis of data has also become more sophisticated, particularly through the use of spreadsheets and other models for planning and cost analysis (for example, activity based costing).

2.2 Information from internal sources

A control system such as a management accounting system must obtain data from within the organisation (from internal sources) for the purposes of planning and control. The system should be designed so that it captures and measures all the data required for providing management with the information they need.

Potential internal sources include:

- the financial accounting records;
- human resource records maintained in support of the payroll system;
- production information;
- sales information; and
- staff (through minutes of meetings etc.)

The essential qualities of good information are as follows:

- Relevance: Information should be relevant to the needs of management. Information must help management to make decisions. Information that is not relevant to a decision is of no value. An important factor in the design of information systems should be the purpose of the information – in what decisions should be made, and what information will be needed to make those decisions?

- Reliability: Information should be reliable. This means that the data should be sufficiently accurate for its purpose. It should also be complete.
- Timeliness: Information should be available in a timely manner. In other words, it should be available for when it is needed by management.
- Economy: The cost of providing the information should not exceed the benefits that it provides. The key factor that limits the potential size of many information systems is that the cost of obtaining additional information is not justified by the additional benefits that the information will provide.

Other qualities of good information include:

- **Completeness**: Information should have all the variables that will be needed for the intended decision.
- **Accuracy:** Information should be correct and precise for the intended purpose.
- **Clarity:** Information must be clear to the user (s).
- **Consistency:** Information must agree at all times with established norms and frameworks.
- **Comprehension:** Information should be presented in a way that the user/ reader can easily comprehend it.
- **Comparability:** This is the degree to which accounting information and policies are consistently applied from one period to another in line with standards.
- **Verifiability:** Verifiability is the extent to which information is reproducible given the same data and assumptions.

In designing a performance measurement system, and deciding what information is required from internal sources, these desirable qualities of good information should influence the design of the system.

Traditionally, management accounting systems obtain internal data from the cost accounting system and costing records. In many organisations, IT systems now integrate costing data with other operational data. This means that data is available to the management accounting system from non-accounting sources.

Example: Information

An information system might be required to provide information about the profitability of different types of customer.

The starting point for the design of this information system is the **purpose** of the information. Why is information about customer profitability needed? The answer might be that the company wants to know which of its customers contribute the most profits, and whether some customers are unprofitable. If some customers are unprofitable, the company will presumably consider ways of improving profitability (for example, by increasing prices charged to those customers) or will decide to stop selling to those customers.

The next consideration is: What data is needed to measure customer profitability? The answer might be that customers should first be divided into different categories, and each category of customer should have certain unique characteristics. Having established categories of customer, information is needed about costs that are directly attributable to each category of customers.

This might be information relating to gross profits from sales, minus the directly attributable selling and distribution costs (and any directly attributable administration costs and financing costs).

Having established what information is required, the next step is to decide how the information should be 'captured' and measured. In this example, a system is needed for measuring each category of customer, sales revenues, costs of sales and other directly attributable costs.

The information should be available for when management intend to review customer profitability. This might be every three months, six months or even annually.

Information from external sources

Managers need information about customers, competitors and other elements in their business environment. The management information system must be able to provide this in the form that managers need, and at the time that they need it.

External information is needed for strategic planning and control. However, it is also often needed for tactical and operational management decisions.

Examples of the external information needed by companies are set out in the table below.

Information area	Examples of information needed
Customers	What are the needs and expectations of customers in the market? Are these needs and expectations changing? What is the potential for our products or services to meet these needs, or to meet them better?
Competitors	Who are they? What are they doing? Can we copy some of their ideas? How large are they, and what is their market share? How profitable are they? What is their pricing policy?
Legal environment	What are the regulations and laws that must be complied with?
Suppliers	What suppliers are there for key products or services? What is the quality of their products or services? What is the potential of new suppliers? What is the financial viability of each supplier?
Political/ environmental issues	Are there any relevant political developments or developments relating to environmental regulation or environmental conditions?
Economic/ financial environment	What is happening to interest rates? What is happening to exchange rates? What is happening in other financial markets? What is the predicted state of the economy?

Possible sources of external information

Sources of external information, some accessible through the Internet, include:

- market research
- supplier price lists and brochures
- trade journals
- newspapers and other media
- government reports and statistics
- reports published by other organisations, such as trade bodies.

Limitations of external information

It is important to recognise the limitations of external information.

- It might not be accurate, and it might be difficult to assess how accurate it is.
- It might be incomplete.
- It might provide either too much or not enough detail.
- It might be difficult to obtain information in the form that is ideally required.
- It might not always be available when required.
- It might be difficult to find.
- It might be out of date.
- It might be misinterpreted.

2.3 Costs of information

Information must be captured and processed, if it is to be useful, and used effectively.

The costs of capturing and processing data should include the cost of the hardware and software used, time spent inputting, analysing and interpreting data (though this might be automated in some instances, for example data input using EPOS systems).

Modern computing equipment makes it very easy to amass huge amounts of data which can be processed into information, but this can bring its own problems:

- The information might not be useful, in which case, the cost of producing it is a waste.
- Important details might be omitted in large volumes of information.

Another important cost is the associated cost of poor decisions based on incomplete information or on a misinterpretation of that information. That could prove very costly indeed.

2.4 Methods of gathering information

Observation

This method involves looking at a process of procedure being executed by others. It is useful in understanding how a programme, system or process actually operates.

Advantages	Disadvantages
Can view operations of a program as they are actually occurring and focus on the information required.	
The observer can adapt to events as they occur.	The fact of being observed might affect the behaviour of those being observed.
	It can be difficult to summarise or categorise observations.
	It is time consuming and can be expensive.

Interviews

Interviews are useful when there is a need to understand the interviewee's responses in more depth.

Advantages	Disadvantages
The interview can deliver a full range at the depth required. The approach is flexible as it allows the interviewer to drill down into the interviewee's responses.	Can be time consuming and costly. It can be hard to analyse and compare the information obtained. An interviewer might bias the interviewee's responses. An interviewee might not answer the questions objectively.

Documentation review

Useful to help understand how a system program operates without interrupting

Advantages	Disadvantages
The researcher can use gain a complete understanding of how a system is meant to operate. Does not disturb the operation of the system. The information already exists and is free from bias.	Can be time consuming and costly. The available information might be incomplete. The interested party must have a clear objective.

Questionnaires

This method can be used gather information in a structured way from a large number of people

Advantages	Disadvantages
It can be completed anonymously Inexpensive to administer Easy to compare and analyse (but analysis may require significant expertise) Can be used to reach a large number of respondents (particularly for online research). Can gather a lot of data.	Addressees may fail to respond. Feedback may not be a true reflection of the respondent's view The wording of questions can bias responses so they must be designed with care Information must be analysed carefully as the respondees are a biased group (i.e. information is gathered only from those who respond and they may have a personal motive for doing so).

3 HIGH/LOW METHOD

Section overview

- The need to estimate fixed and variable costs
- High/low analysis
- High/low analysis and forecasting
- High/low analysis with a step change in fixed costs
- High/low analysis with a change in the variable cost per unit

3.1 The need to estimate fixed and variable costs

To prepare accurate cost budgets, it is important to understand how costs 'behave'. Cost behaviour refers to the way in which total costs increase as the volume of an activity increases.

It is normally assumed that total costs can be analysed into fixed costs and a variable cost per unit of activity, such as a variable cost per unit of product or per hour of service. Some overhead costs are a mixture of fixed costs and variable costs, but these can be separated into a fixed cost portion and a variable cost portion.

To prepare reliable cost budgets or cost estimates, it may be necessary to estimate fixed costs and variable costs.

- Direct material costs are normally 100% variable costs.
- Direct labour costs may be treated as variable costs. However, when there is a fixed labour force, direct labour costs may be budgeted as fixed costs.
- Overhead costs may be treated as fixed costs. However, for an accurate analysis of overhead costs, it may be necessary to make an estimate of fixed costs and variable costs. These estimates are often based on an analysis of historical costs.

You will be familiar with the following two techniques for estimating fixed and variable costs from your previous studies:

- the high low method; and
- linear regression analysis.

A full explanation of each of these techniques is repeated here for your convenience.

3.2 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 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

Step 1: Take the activity level and cost for:

- the highest activity level
- the lowest activity level.

Step 2: The variable cost per unit of activity can be calculated as:

difference in total costs/difference in the number of units of activity.

Step 3: Having calculated a variable cost per unit of activity, fixed cost can be calculated by substitution into one of the cost expressions. The difference between the total cost at this activity level and the total variable cost at this activity level is the fixed cost.

Step 4: Construct the total cost function.

This is best seen with an example.

Example: High/low method

A company has recorded the following costs in the past six months:

Month	Production (units)	Total cost (₦)
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

Step 1: Identify the highest and lowest activity levels and note the costs associated with each level.

	Production (units)	Total cost (₦)
March	8,200	48,700
January	5,800	40,300

Step 2: Compare the different activity levels and associated costs and calculate the variable cost:

	Production (units)	Total cost (₦)
March	8,200	48,700
January	5,800	40,300
	2,400	8,400

Therefore: 2,400 units cost an extra ₦8,400.

Therefore: The variable cost per unit = ₦8,400/2,400 units = ₦3.5 per unit

Step 3: Substitute the variable cost into one of the cost functions (either high or low).

Total cost of 8,200 units:

Fixed cost + Variable cost = ₦48,700

Fixed cost + (8,200 × ₦3.5) = ₦48,700

Fixed cost + ₦28,700 = ₦48,700

Fixed cost = ₦48,700 − ₦28,700 = ₦20,000

Step 4: Construct total cost function

Total cost = a +bx = 20,000 + 3.5x

Note that at step 3 it does not matter whether the substitution of variable cost is into the high figures or the low figures.

Example: Cost of other levels of activity

Return to step 3 above. Then, substitute the low figures for high figures.

Step 3: Substitute the variable cost into one of the cost functions (either high or low).

Total cost of 5,800 units:

Fixed cost + Variable cost = ₦40,300

Fixed cost + (5,800 × ₦3.5) = ₦40,300

Fixed cost + ₦20,300 = ₦40,300

Fixed cost = ₦40,300 – ₦20,300 = ₦20,000

3.3 High/low analysis and forecasting

Once derived, the cost function can be used to estimate the cost associated with levels of activity outside the range of observed data. Thus it can be used to forecast costs associated with future planned activity levels.

Example: High/low method

The company is planning to make 7,000 units and wishes to estimate the total costs associated with that level of production.

Total cost = ₦20,000 + ₦3.5x

Total cost of 7,000 units = ₦20,000 + (₦3.5 × 7,000) = ₦44,500

3.4 High/low analysis with a step change in fixed costs

High/low analysis can also be used 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 in naira value, 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 use the same fixed cost figure. After this adjustment the difference between the high and low costs is solely due to variable cost. The variable cost can be identified and cost functions constructed for each side of the step.

The method

Step 1: Take the activity level and cost for:

- the highest activity level
- the lowest activity level.

Step 2: Make an adjustment for the step in fixed costs;

- add the step in fixed costs to the total costs of the lower level of activity; or
- deduct the step in fixed costs from the total costs of the higher level of activity.

Step 3: The variable cost per unit of activity can be calculated as:

$$^{\text{difference in total costs}}/_{\text{difference in the number of units of activity}}.$$

Step 4: Having calculated a variable cost per unit of activity, fixed cost can be calculated by substitution into one of the cost expressions. (use the unadjusted pair).

Step 5: Construct the total cost function of the unadjusted level.

Step 6: Construct the total cost function for the adjusted level by reversing the adjustment to its fixed cost.

This is best seen with an example.

Example: High/low method with step in fixed costs

A company has identified that total fixed costs increase by ₦15,000 when activity level equals or exceeds 19,000 units. The variable cost per unit is constant over this range of activity.

The company has identified the following costs at two activity levels. (Step 1)

	Production (units)	Total cost (₦)
High	22,000	195,000
Low	17,000	165,000

Step 2: Make an adjustment for the step in fixed costs.

	Production (units)	Total cost (₦)
High	22,000	195,000
Low (165,000 + 15,000)	17,000	180,000

Step 3: Compare the different activity levels and associated costs and calculate the variable cost:

	Production (units)	Total cost (₦)
High	22,000	195,000
Low	17,000	180,000
	5,000	15,000

Therefore: 5,000 units cost an extra ₦15,000.

Therefore: The variable cost per unit = ₦15,000/5,000 units = ₦3 per unit

Step 4: Substitute the variable cost into one of the cost functions (either high or low).

Total cost of 22,000 units:

Fixed cost + Variable cost = ₦195,000

Fixed cost + (22,000 × ₦3) = ₦195,000

Fixed cost + ₦66,000 = ₦195,000

Fixed cost = ₦195,000 − ₦66,000 = ₦129,000

Step 5: Construct total cost function (unadjusted level) above 19,000 units

Total cost = a +bx = 129,000 + 3x

Step 6: Construct total cost function below 19,000 units

Total cost = a +bx = (129,000 − 15,000) + 3x

Total cost = a +bx = 114,000 + 3x

The cost functions can be used to estimate total costs associated with a level as appropriate.

Example: High/low method

The company is planning to make 20,000 units and wishes to estimate the total costs associated with that level of production.

Total cost = ₦129,000 + ₦3x

Total cost of 20,000 units = 129,000 + (₦3 × 20,000) = ₦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.

The costs associated with a third activity level must be found. This activity level could be either side of the activity level that triggers the step increase in fixed costs. This means that there are two activity levels which share the same fixed cost (though it is unknown).These can be compared to identify the variable cost.

The fixed cost at any level can then be calculated by substitution and the fixed cost the other side of the step can be calculated from the first fixed cost.

Example: High/low method with step in fixed costs

A company has identified that total fixed costs increase by 20% when activity level equals or exceeds 7,500 units. The variable cost per unit is constant over this range of activity.

The company has identified the following costs at three activity levels. (Step 1)

	Production (units)	Total cost (₦)
High	11,000	276,000
Middle	8,000	240,000
Low	5,000	180,000

Step 2: Choose the pair which is on the same side as the step.

	Production (units)	Total cost (₦)
High	11,000	276,000
Middle	8,000	240,000

Step 3: Compare the different activity levels and associated costs and calculate the variable cost:

	Production (units)	Total cost (₦)
High	11,000	276,000
Middle	8,000	240,000
	3,000	36,000

Therefore: 3,000 units cost an extra ₦36,000.

Therefore: The variable cost per unit = $^{₦36,000}/_{3,000 \text{ units}}$ = ₦12 per unit

Step 4: Substitute the variable cost into one of the cost functions

Total cost of 11,000 units:

Fixed cost + Variable cost = ₦276,000

Fixed cost + (11,000 × ₦12) = ₦276,000

Fixed cost + ₦132,000 = ₦276,000

Fixed cost = ₦276,000 – ₦132,000 = ₦144,000

Step 5: Construct total cost function above 7,500 units

Total cost = a +bx = 144,000 + 12x

Step 6: Construct total cost function below 7,500 units

Total cost = a +bx = (144,000 × $^{100}/_{120}$) + 12x

Total cost = a +bx = 120,000 + 12x

The cost functions can be used to estimate total costs associated with a level as appropriate.

3.5 High/low analysis with 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: High/low method with step in fixed costs

A company has identified that total fixed costs are constant over all levels 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.

The company has identified the following costs at three activity levels. (Step 1)

	Production (units)	Total cost (₦)
High	30,000	356,000
Middle	25,000	320,000
Low	20,000	300,000

Step 2: Choose the pair which is on the same side as the change.

	Production (units)	Total cost (₦)
High	30,000	356,000
Middle	25,000	320,000

Step 3: Compare the different activity levels and associated costs and calculate the variable cost:

	Production (units)	Total cost (₦)
High	30,000	356,000
Middle	25,000	320,000
	5,000	36,000

Therefore: 5,000 units cost an extra ₦36,000.

Therefore: The variable cost per unit above 24,000 units

= ₦36,000/5,000 units = ₦7.2 per unit

Therefore: The variable cost per unit below 24,000 units

= ₦7.2 per unit × 100/90 = ₦8 per unit

Step 4: Substitute the variable cost into one of the cost functions

Total cost of 30,000 units:

Fixed cost + Variable cost = ₦356,000

Fixed cost + (30,000 × ₦7.2) = ₦356,000

Fixed cost + ₦216,000 = ₦356,000

Fixed cost = ₦356,000 – ₦216,000 = ₦140,000

Step 5: Construct total cost function above 24,000 units

Total cost = a +bx = 140,000 + 7.2x

Step 6: Construct total cost function below 24,000 units

Total cost = a +bx = 140,000 + 8x

The cost functions can be used to estimate total costs associated with a level as appropriate.

4 LINEAR REGRESSION ANALYSIS

Section overview

- The purpose of linear regression analysis
- The linear regression formulae
- Linear regression analysis and forecasting

4.1 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 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.

4.2 The linear regression formulae

Linear regression analysis is a statistical technique for calculating a line of best fit where there are different values for ***x***, and for each value of ***x*** there is an associated value of ***y*** in the data.

The linear regression formulae for calculating ***a*** and ***b*** are shown below.

Formula: Regression analysis formula

Given a number of pairs of data a line of best fit (y = a + bx) can be constructed by calculating values for a and b using the following formulae.

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

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

Where:

x, y = values of pairs of data.

n = the number of pairs of values for x and y.

$\sum$ = A sign meaning the sum of. (The capital of the Greek letter sigma).

x = Independent variable (units of activity)

y = Dependent variable (Amounts / Costs)

a = Fixed costs / y intercept

b = Variable costs per unit of activity /Slope/Gradient/Regression coefficient.

Note: the term b must be calculated first as it is used in calculating a.

Approach

- Set out the pairs of data in two columns, with one column for the values of ***x*** and the second column for the associated values of ***y***. (For example, ***x*** for output and ***y*** for total cost.
- Set up a column for ***x²***, calculate the square of each value of ***x*** and enter the value in the ***x²*** column.
- Set up a column for ***xy*** and for each pair of data multiply ***x*** by ***y*** and enter the value in the ***xy*** column.
- Sum each column.
- Enter the values into the formulae and solve for ***b*** and then ***a***. (It must be in this order as you need ***b*** to find ***a***).

Linear regression analysis is widely used in economics and business. One application is that it can be used to estimate fixed costs and variable cost per unit (or number of units) from historical total cost data.

The following example illustrates this use

Example: Linear regression analysis

A company has recorded the following output levels and associated costs in the past six months:

Month	Output (000 of units)	Total cost (₦m)
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: Construct the equation of a line of best fit for this data.

Working:

	x	**y**	**x²**	**xy**
January	5.8	40.3	33.64	233.74
February	7.7	47.1	59.29	362.67
March	8.2	48.7	67.24	399.34
April	6.1	40.6	37.21	247.66
May	6.5	44.5	42.25	289.25
June	7.5	47.1	56.25	353.25
	41.8	268.3	295.88	1,885.91
	$= \sum x$	$= \sum y$	$= \sum x^2$	$= \sum xy$

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2} \qquad b = \frac{6(1,885.91) - (41.8)(268.3)}{6(295.88) - (41.8^2)}$$

$$b = \frac{11,315.46 \quad 11,214.94}{1,775.28 - 1,747.24} = \frac{100.52}{28.04} = 3.585$$

This is the cost in millions of naira of making 1,000 units

$$a = \frac{\sum y}{n} - \frac{b\sum x}{n} \qquad a = \frac{268.3}{6} - \frac{3.585(41.8)}{6}$$

$$a = 44.72 - 24.98 = 19.74$$

Line of best fit:

$$y = a + bx$$

$$y = 19.74 + 3.585x$$

4.3 Linear regression analysis and forecasting

Once derived, the cost function can be used to estimate the cost associated with levels of activity outside the range of observed data. Thus it can be used to forecast costs associated with future planned activity levels.

Example: Linear regression analysis

The company is planning to make 9,000 units and wishes to estimate the total costs associated with that level of production.

$$y = 19.74 + 3.585x$$

$$y = 19.74 + 3.585 \times 9$$

$$y = 52.00$$

Linear regression analysis can also be used to forecast other variables (e.g. demand, sales volumes etc.).

This is done by constructing an equation to describe a change in value over time. Regression analysis is carried out in the usual way with time periods identified as the independent variable. The dependent variable under scrutiny can then be estimated for various periods into the future.

This rests on the assumption that a linear trend in the past will continue into the future.

5 MARGINAL COSTING AND ABSORPTION COSTING

Section overview

- Absorption costing
- Marginal costing
- The difference in profit between marginal costing and absorption costing
- Advantages and disadvantages of absorption costing
- Advantages and disadvantages of marginal costing

5.1 Absorption costing

Absorption costing measures cost of a product or a service as:

- its direct costs (direct materials, direct labour and sometimes direct expenses and variable production overheads); plus
- a share of fixed production overhead costs.

It is a system of costing in which a share of fixed overhead costs is added to direct costs and variable production overheads, to obtain a full cost.

This might be:

- a full production cost, or
- a full cost of sale

This was covered in an earlier chapter but a brief revision is provided here for your convenience.

- Production overheads are indirect costs. This means that the costs (unlike direct costs) cannot be attributed directly to specific items (products) 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, a rate per amount of material 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. (However, 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 as follows:

Formula: Overhead absorption rate

$$\frac{\text{Total allocated and apportioned overheads}}{\text{Volume of activity in the period}}$$

Which is:

$$\frac{\text{Budgeted production overhead expenditure for the period}}{\text{Budgeted activity in the period}}$$

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.

Under- and over-absorption

Overhead absorption rates are decided in advance (before the period under review).

Actual overhead expenditure and actual production volume 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.

Illustration: Under of over-absorbed fixed overhead

			₦
Amount absorbed:			
Actual number of units made (or hours used)	×	Predetermined absorption rate	X
Actual expenditure in the period			(X)
Over/(under) absorbed			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.

Example: Absorption costing

A company manufactures and sells a range of products in a single factory. Its budgeted production overheads for Year 6 were ₦150,000, and budgeted direct labour hours were 50,000 hours.

Actual results in Year 6 were as follows:

	₦	
Sales	630,000	
Direct materials costs	130,000	
Direct labour costs	160,000	
Production overhead	140,000	(40,000 hours)
Administration overhead	70,000	
Selling and distribution overhead	90,000	

There was no opening or closing inventory at the beginning or end of Year 6.

The company uses an absorption costing system, and production overhead is absorbed using a direct labour hour rate.

The above information would be used as follows:

a. The predetermined absorption rate is ₦150,000/50,000 hours = ₦3 per direct labour hour.

b	**Under absorption**	₦
	Overhead absorbed (40,000 hours @ ₦3 per hour)	120,000
	Overhead incurred (actual cost)	(140,000)
	Under absorption	(20,000)

c	**The full production cost:**	₦
	Direct materials costs	130,000
	Direct labour costs	160,000
	Production overhead absorbed (40,000 hours × ₦3)	120,000
	Full production cost (= cost of sales in this example)	410,000

The profit for the year is reported as follows. Notice that under-absorbed overhead is an adjustment that reduces the reported profit. Over-absorbed overhead would be an adjustment that increases profit.

		₦	₦
d	Sales		630,000
	Full production cost of sales		410,000
	Under-absorbed overhead		20,000
			(430,000)
			200,000
	Administration overhead	70,000	
	Selling and distribution overhead	90,000	
			(160,000)
	Profit for Year 6		40,000

The amount of under- or over-absorbed overheads is written to profit or loss for the year as an adjusting figure.

- If overhead is under-absorbed overhead the profit is adjusted down (because production costs have been understated)
- If overhead is over-absorbed the profit is adjusted upwards.

Note that the recognition of the under or over absorbed overhead in the statement of profit or loss results in the fixed production overhead figure (which was originally based on an absorption rate) being restated to the actual fixed overhead incurred.

Example: Absorption costing

Returning to the facts of the previous example.

	₦
Overhead absorbed (40,000 hours @ ₦3 per hour)	120,000
Under absorption	20,000
Overhead incurred (actual cost)	140,000

5.2 Marginal costing

Marginal costing is an alternative to absorption costing. In marginal costing, fixed production overheads are not absorbed into product costs but expensed in the period.

Marginal costing is useful in decision making as it focuses on the change in total costs brought about by an increase or decrease in a level of activity. This is covered in more detail in later chapters of this text.

5.3 The difference in profit between marginal costing and absorption costing

The profit for an accounting period calculated with marginal costing is different from the profit calculated with absorption costing.

The difference in profit is due **entirely** to the differences in inventory valuation.

The main difference between absorption costing and marginal costing is that in absorption costing, inventory cost includes a share of fixed production overhead costs.

- The opening inventory contains fixed production overhead that was incurred last period. Opening inventory is written off against profit in the current period. Therefore, part of the previous period's costs are written off in the current period income statement.
- The closing inventory contains fixed production overhead that was incurred in this period. Therefore, this amount is not written off in the current period income statement but carried forward to be written off in the next period income statement.

The implication of this is as follows (assume costs per unit remain constant):

- When there is no change in the opening or closing inventory, exactly the same profit will be reported using marginal costing and absorption costing.
- If inventory increases in the period (closing inventory is greater than opening inventory),
  - the increase is a credit to the income statement reducing the cost of sales and increasing profit;
  - the increase will be bigger under total absorption valuation than under marginal costing valuation (because the absorption costing inventory includes fixed production overhead); therefore
  - the total absorption profit will be higher.
- If inventory decreases in the period (closing inventory is less than opening inventory),
  - the decrease is a debit to the income statement;
  - the decrease will be bigger under total absorption valuation than under marginal costing valuation (because the absorption costing inventory includes fixed production overhead); therefore
  - the total absorption profit will be lower.

Example: Absorption costing

Makurdi Manufacturing makes and sells a single product:

	₦
Selling price per unit	150
Variable production costs per unit	70
Fixed overhead per unit (see below)	50
Total absorption cost per unit (used in inventory valuation)	120

Normal production	2,200 units per month
Budgeted fixed production overhead	₦110,000 per month
Fixed overhead absorption rate	₦110,000/2,200 units= ₦50 per unit

The following data relates to July and August:

	July	August
Fixed production costs	₦110,000	₦110,000
Production	2,000 units	2,500 units
Sales	1,500 units	3,000units

There was no opening inventory in July.

This means that there is no closing inventory at the end of August as production in the two months (2,000 + 2,500 units = 4,500 units) is the same as the sales (1,500 + 3,000 units = 4,500 units)

Example (continued): Total absorption cost profit statement

	July	August
Sales:		
1,500 units × ₦150	225,000	
3,000 units × ₦150		450,000
Opening inventory	nil	60,000
Variable production costs		
2,000 units × ₦70	140,000	
2,500 units × ₦70		175,000
Fixed production costs (absorbed)		
2,000 units × ₦50	100,000	
2,500 units × ₦50		125,000
Under (over) absorption		
200 units @ ₦50	10,000	
300 units @ ₦50		(15,000)
	250,000	345,000
Closing inventory		
500 units @ (70 + 50)	(60,000)	
Zero closing inventory		nil
Cost of sale	(190,000)	(345,000)
Profit for the period	35,000	105,000

Example (continued): Marginal costing

Makurdi Manufacturing makes and sells a single product:

	₦
Selling price per unit	150
Variable production costs per unit	70

Budgeted fixed production overhead ₦110,000 per month

The following actual data relates to July and August:

	July	August
Fixed production costs	₦110,000	₦110,000
Production	2,000 units	2,500 units
Sales	1,500 units	3,000units

There was no opening inventory in July.

Marginal costing profit statements are as follows:

	July	August
Sales:		
1,500 units × ₦150	225,000	
3,000 units × ₦150		450,000
Opening inventory	nil	35,000
Variable production costs		
Direct material: 2,000 units × ₦35	70,000	
Direct labour: 2,000 units × ₦25	50,000	
Variable overhead 2,000 units × ₦10	20,000	
Direct material: 2,500 units × ₦35		87,500
Direct labour: 2,500 units × ₦25		62,500
Variable overhead 2,500 units × ₦10		25,000
Closing inventory		
500 units @ (70)	(35,000)	
Zero closing inventory		nil
Cost of sale	(105,000)	(210,000)
Contribution	120,000	240,000
Fixed production costs (expensed)	(110,000)	(110,000)
Profit for the period	10,000	130,000

The difference between the two profit figures is calculated as follows:

Formula: Profit difference under absorption costing (TAC = total absorption costing) and marginal costing (MC)

Assuming cost per unit is constant across all periods under consideration.

Number of units increase or decrease $\times$ fixed production overhead per unit

Returning to the previous example:

Example(continued): Profit difference

	July	August	Over the two months
	₦	₦	₦
Absorption costing profit	35,000	105,000	140,000
Marginal costing profit	10,000	130,000	140,000
Profit difference	25,000	(25,000)	nil

This profit can be explained the different way the inventory movement is costed under each system:

	Units	Units	Units
Closing inventory		nil	nil
2,000 units made less 1,500 sold	500		
Opening inventory	nil	500	nil
	500	(500)	nil
Absorbed fixed production overhead per unit (₦)	50	50	50
Profit difference (₦)	25,000	(25,000)	nil

Note that the difference is entirely due to the movement in inventory value:

Example: Profit difference – due to inventory movement

TAC inventory movement:	July	August	Over the two months
	₦	₦	₦
Closing inventory	60,000	nil	nil
Opening inventory	nil	(60,000)	nil
	60,000	(60,000)	nil
MC inventory movement:			
Closing inventory	35,000	nil	nil
Opening inventory	nil	(35,000)	nil
	35,000	(35,000)	nil
Profit difference	25,000	(25,000)	nil

Example: MC vs TAC

A company manufactures and sells a product.

The following information is relevant about the product

	₦
Selling price per unit	35
Variable cost per unit	8
Fixed cost per unit (based on budgeted overhead of ₦120,000 and normal level of activity of 20,000 units).	6

	Units
Opening inventory	4,000
Actual production	20,000
Closing inventory	3,000
Therefore, sales are (4,000 + 20,000 – 3,000)	21,000

Example (continued): MC vs TAC

Operating statements can be prepared as follows:

	MC	TAC
Sales (21,000 × ₦35)	735,000	735,000
Cost of sales		
MC = (21,000 × ₦8)	(168,000)	
TAC = (21,000 × ₦14)		(294,000)
Fixed production cost	(120,000)	
	447,000	441,000

The profit figures are reconciled as follows:

	Units
Opening inventory	4,000
Closing inventory	3,000
Decrease	1,000
Difference in cost per unit	₦6
	₦6,000

	₦
MC profit	447,000
Inventory valuation difference	(6,000)
TAC profit	441,000

Practice question **1**

The following information is relevant about a product

	₦
Selling price per unit	35
Variable cost per unit	8
Fixed cost per unit (based on budgeted overhead of ₦120,000 and normal level of activity of 20,000 units).	6

	Units
Opening inventory	2,000
Actual production	20,000
Closing inventory	4,000
Therefore, sales are (2,000 + 20,000 – 4,000)	18,000

Required:

Prepare MC and TAC operating statements and reconcile the profit difference.

Practice question **2**

A company manufactures and sells product X.

The following information is relevant about the product:

	₦
Selling price per unit	50
Variable cost per unit	30
Fixed cost per unit (based on budgeted overhead of ₦100,000 and normal level of activity of 25,000 units).	4

	Units
Opening inventory	2,000
Closing inventory	1,500
Actual production	25,500

Required

a) Prepare a marginal cost profit statement.

b) Prepare an absorption cost profit statement. (Remember to adjust for the over absorption of overhead).

c) Reconcile the two profit figures by comparing the impact of the inventory movement under each approach.

5.4 Advantages and disadvantages of absorption costing

Advantages of absorption costing

- Inventory values include an element of fixed production overheads. This is consistent with the requirement in financial accounting that (for the purpose of financial reporting) inventory should include production overhead costs.
- Calculating under/over absorption of overheads may be useful in controlling fixed overhead expenditure.
- By calculating the full cost of sale for a product and comparing it will the selling price, it should be possible to identify which products are profitable and which are being sold at a loss.

Disadvantages of absorption costing

- Absorption costing is a more complex costing system than marginal costing.
- Absorption costing does not provide information that is useful for decision making (like marginal costing does).

5.5 Advantages and disadvantages of marginal costing

Advantages of marginal costing

- It is easy to account for fixed overheads using marginal costing. Instead of being apportioned they are treated as period costs and written off in full as an expense the income statement for the period when they occur.
- There is no under/over-absorption of overheads with marginal costing, and therefore no adjustment necessary in the income statement at the end of an accounting period.
- Marginal costing provides useful information for decision making.
- Contribution per unit is constant, unlike profit per unit which varies as the volume of activity varies.

Disadvantages of marginal costing

- Marginal costing does not value inventory in accordance with the requirements of financial reporting. (However, for the purpose of cost accounting and providing management information, there is no reason why inventory values should include fixed production overhead, other than consistency with the financial accounts.)
- Marginal costing can be used to measure the contribution per unit of product, or the total contribution earned by a product, but this is not sufficient to decide whether the product is profitable enough. Total contribution has to be big enough to cover fixed costs and make a profit.

6 ACTIVITY BASED COSTING

Section overview

- Criticisms of absorption costing
- Introduction to activity based costing
- Activities
- Cost drivers and cost pools
- When using ABC might be appropriate
- Advantages and disadvantages of ABC

6.1 Criticisms of absorption costing

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

- Production overhead costs are often high relative to direct production costs. Therefore, a system of adding overhead costs to product costs by using time spent in production (direct labour hours or machine hours) is difficult to justify.
- A full cost of production has only restricted value for many types of management decision.

However, traditional absorption costing is still in use with some companies.

- 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 is also argued that absorption costing is useful for some pricing decisions. (Pricing is covered in a later paper).

A number of alternative costing methods have been developed with a view to replacing the traditional methods. One such method is activity-based costing.

6.2 Introduction to activity-based costing

Activity-based costing (ABC) is a form of absorption costing that takes a different approach to the apportionment and absorption of production overhead costs.

Activity-based costing is based on the following ideas:

- In a modern manufacturing environment, a large proportion of total costs are overhead costs, and direct labour costs are relatively small.
- It is appropriate to trace these costs as accurately as possible to the products that create the cost because overhead costs are large.

- The traditional methods of absorbing production overhead costs on the basis of direct labour hours or machine hours have no rational justification as 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 relate more to the volume and complexity of customer orders or the number of batch production runs, rather than hours worked in production.

6.3 Activities

Activity-based costing (ABC) takes the view that many production overhead costs can be associated with particular activities other than direct production work.

If such activities can be identified and costs linked to them overhead costs can then be added to product costs by using a separate absorption rate for each activity.

ABC costing of overheads and estimate of 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.

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;
- purchasing;
- quality control and inspection;
- production planning; and
- repairs and maintenance.

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

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; and
- 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.

6.4 Cost drivers and cost pools

Cost drivers

For each activity, there should be a cost driver. A cost driver is the 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.

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

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.

Possible examples include:

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 dispatch	Number of deliveries Made	Number of deliveries for each product

Cost pools

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

ABC absorbs overheads 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.

The cost absorbed under ABC might be very different to that absorbed using a traditional, volume-based approach.

Example: ABC vs traditional, volume based absorption

A manufacturing company makes four products and incurs estimated material handling costs of ₦250,000 per month. (This is the cost pool for material handling cost).

The company produces 160,000 units per month and absorbs material handling cost on the number of units. This gives a material handling cost of ₦1.5625 (₦250,000 ÷ 160,000 units)

The material handling cost is absorbed as follows:

Product	Units produced	Unit cost (₦)	Cost absorbed (₦)
W	60,000	₦1.5625	93,750
X	33,000	₦1.5625	51,563
Y	40,000	₦1.5625	62,500
Z	27,000	₦1.5625	42,187
	160,000	₦1.5625	250,000

The company has instigated a project to see if ABC costing would be appropriate.

The project has identified that a large part of the material handling costs are incurred in receiving material orders and that the same effort goes into receiving orders regardless of the size of the order. Order sizes differ substantially.

The company has identified the following number of orders in respect of material for each type of product.

Product	Number of orders
W	15
X	22
Y	4
Z	9
	50

An ABC cost per order (hence cost per unit) can be estimated as follows:

If the cost driver for order handling is the number of orders handled, the budgeted order handling cost will be ₦5,000 per order (₦250,000/50).

Overhead costs will be charged to products as follows:

Product	Number of orders	Cost per order	Apportioned cost	Units produced	Unit cost
W	15	₦5,000	75,000	60,000	1.25
X	22	₦5,000	110,000	33,000	3.33
Y	4	₦5,000	20,000	40,000	0.50
Z	9	₦5,000	45,000	27,000	1.67
	50	₦5,000	250,000	160,000	

The above example shows that the material handling overhead absorbed to each type of product is very different under the two approaches.

For example, only 33,000 units of product X are made (out of a total of 160,000 units). However, product X requires 22 orders out of a total of 60 and it is the number of orders that drive this cost.

The traditional approach recognised ₦51,563 as relating to product but ABC, using the number of orders as the driver results in ₦110,000 being absorbed by product X.

The above example shows the difference between traditional absorption and ABC using a single cost. In reality there would be more than one activity used as a basis for absorption leading to a series of absorption rates (per activity).

Also note that one of the absorption methods might be a volume-based method. The point is that traditional absorption methods treat all costs as varying according to a volume measure whereas ABC splits the total and treats each part of the total cost according to what drives it.

Example: ABC

A company makes three products, X, Y and Z using the same direct labour employees and the same machine for production.

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

	Labour hours per unit	Machine hours per unit	Material cost per unit (₦)	Number of units produced
Product X	0.25	0.75	100	1,500
Product Y	0.75	0.50	60	2,500
Product Z	0.50	1.50	120	14,000

Direct labour costs ₦160 per hour.

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	196,350
Costs relating to inspection	458,150
Costs relating to set-ups	392,700
Costs relating to materials handling	261,800
Total production overhead	1,309,000

Example (continued): ABC

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	Machine hours
Product X	360	80	40	1,125
Product Y	80	120	80	1,250
Product Z	960	500	280	21,000
	1,400	700	400	23,375

Machine costs are absorbed on a machine hour basis.

The costs per unit for each product may be estimated as follows using ABC principles.

Step 1: Cost per activity

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

Example (continued): ABC

Step 2: Allocate overheads to product types based on cost per activity and cost drivers

	X	Y	Z
	₦	₦	₦
Set-ups			
80 set ups × ₦561	44,880		
120 set ups × ₦561		67,320	
500 set ups × ₦561			280,500
Inspection			
360 set ups × ₦327.25	117,810		
80 set ups × ₦327.25		26,180	
960 set ups × ₦327.25			314,160
Materials handling			
40 movements × ₦654.50	26,180		
80 movements × ₦654.50		52,360	
280 movements × ₦654.50			183,260
Machinery operations			
1,125 hours × ₦8.40	9,450		
1,250 hours × ₦8.40		10,500	
21,000 hours × ₦8.40			176,400
Overhead costs per product	198,320	156,360	954,320

Example (continued): ABC

Step 3: Calculate overhead per unit (if required)

	X	Y	Z
Overhead costs per product (from step 2)	₦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

Step 4: Calculate total production cost per unit (if required)

Production cost per unit: ABC	X	Y	Z
	₦	₦	₦
Direct materials	100.00	60.00	120.00
Direct labour	40.00	120.00	80.00
Production overhead (from step3)	132.21	62.54	68.17
Full production cost per unit	272.21	242.50	268.17

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.

6.5 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.

6.6 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 also provides information that could be relevant to long-term cost control and long-term product selection or product pricing.
- 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

- ABC systems are costly to design and use. The costs might not justify the benefits.
- 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.
- 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.
- Identifying the most suitable cost driver for a cost pool/activity is often difficult. Many activities and cost pools have more than one cost driver.
- Traditional cost accounting systems may be more appropriate for the purpose of inventory valuation and financial reporting.

7 ETHICS IN PERFORMANCE MANAGEMENT

Section overview

- ICAN's Code of Ethics
- Threats for accountants in business
- Preparation and reporting of accounting information

7.1 ICAN's Code of Ethics

Accountants in business may sometimes find themselves in a situation where their professional values are in conflict with their responsibilities in their job. ICAN's Professional Code of Conduct provides rules and guidance that members and student members must follow when ethical issues arise.

ICAN's Code of Ethics sets out five fundamental principles of ethical behaviour for accountants. These are:

- integrity;
- objectivity: accountants should not allow bias, conflicts of interest or undue influence of others to override their objectivity and judgement;
- professional competence and due care: accountants have a duty to maintain their professional knowledge and skill and they should not undertake work where they do not have sufficient knowledge to do the work well;
- confidentiality: accountants must respect the confidentiality of information acquired in their work and should not disclose such information to third parties without authority; and
- professional behaviour.

Integrity

Members should be straightforward and honest in all professional and business relationships. Integrity implies not just honesty but also fair dealing and truthfulness.

For example, an accountant preparing performance information must not be associated with reports, returns, or any other communications where they believe that the information:

- Contains a materially false or misleading statement;
- Contains statements or information furnished recklessly; or
- Omits or obscures information where the omission or obscurity would be misleading.

7.2 Threats for accountants in business

Working for an employer should have no bearing on the requirement for accountants to respect the five fundamental principles. The work of accountants will often further the aims of their employer, and this is not a problem except when circumstances arise that create a conflict with their duty to comply with the fundamental principles. Threats to compliance with the fundamental principles may arise due to:

- self-interest;
- self-review;
- advocacy;
- familiarity; and
- intimidation.

Accountants in business are often responsible for the preparation of accounting information.

They must not prepare financial information in a way that is misleading. However threats to compliance with the fundamental principles may arise in the area of performance management, for example where accountants may be tempted or may come under pressure to produce misleading performance reports or forecasts.

Accountants responsible for the preparation of financial information must ensure that the information is technically correct and is adequately disclosed.

There is danger of influence from senior managers to present figures that inflate profits or assets. This puts the accountant in a difficult position. On one hand, they wish to prepare proper information and on the other hand, there is a possibility they might lose their job if they do not comply with their manager's wishes.

Self- interest threats

Self-interest threats may occur as a result of the financial or other personal interests of an accountant or their immediate or close family members. Self-interest may tempt an accountant to withhold information that might damage them financially or get them into trouble with their bosses.

Examples of circumstances that may create self-interest threats in performance management include:

- Incentive compensation arrangements: an accountant's bonus may depend on improvements in reported efficiencies or profitability
- Inappropriate personal use of company assets
- Concern about job security
- Commercial pressures from outside the employing organisation.

Example: Self- interest threats

Adeola is member of ICAN working as a unit accountant.

He is a member of a bonus scheme under which staff receive a bonus of 10% of their annual salary if costs for the year are less than budget.

Adeola has been preparing a report on costs, and he has found that by omitting some items of cost, the reported costs will just come in under budget, making him (and his colleagues) eligible for their bonus.

Analysis:

Adeola faces a self-interest threat. He must ignore the temptation to falsify the cost figures.

Self-review threats

Self-review threats occur when a previous judgement or decision is reviewed by the person who made the original judgement or decision. The temptation may be for the individual concerned to confirm on review that the original judgement or decision was correct - when it was not - instead of admitting a mistake.

Example: Self-interest threat

Kunle, an accountant with a manufacturing company, worked on a costing exercise for a new product. He estimated that the unit cost for the new product would be ₦100. However, he made several mistakes in his cost estimate and the actual unit cost was 40% higher than he had stated.

After the product went into production, Kunle was asked to review his original cost estimate and report on its accuracy. On carrying out the review, Kunle was alarmed to find the errors he had made and was concerned that admitting his mistake would damage his career prospects with his employer. He was therefore tempted to report that actual unit costs for the product were very close to his original estimate.

Analysis:

Kunle faces a threat to his integrity and objectivity from this self-review.

Kunle must admit his mistake and report the 'correct' actual cost of the new product.

Advocacy threats

An accountant in business may often need to promote the organisation's position by providing financial information. As long as information provided is neither false nor misleading such actions would not create an advocacy threat.

Familiarity threats

Familiarity threats occur when, because of a close relationship, members become too sympathetic to the interests of others. Examples of circumstances that may create familiarity threats include:

- An accountant being in a position to influence financial or non-financial reporting or business decisions where an immediate or close family member is in a position to benefit from that influence.
- Long association with business contacts can influence the contents of a performance report.

Intimidation threats

Intimidation threats occur when an individual's conduct is influenced by fear or threats (for example, from an aggressive and dominating boss).

Examples of circumstances that may create intimidation threats include:

- Threat of dismissal or replacement over a disagreement about the way in which performance information is to be reported.
- A dominant personality attempting inappropriately to influence the content of a report.

7.3 Preparation and reporting of accounting information

Performance reporting involves the preparation and reporting of information that is used mostly by managers inside the employing organisation. Such information may include financial or management information, for example:

- forecasts and budgets;
- performance statements; and
- performance analysis.

Information must be prepared and presented honestly.

Threats to compliance with the fundamental principles, for example self-interest threats or intimidation threats to objectivity or professional competence and due care, may be created where an accountant in business is pressured (either by a boss or by the possibility of personal gain) to become associated with misleading information.

The significance of such threats will depend on factors such as the source of the pressure and the degree to which the information is, or may be, misleading.

The significance of the threats should be evaluated and unless they are clearly insignificant, safeguards should be considered and applied as necessary to eliminate them or reduce them to an acceptable level. Such safeguards may include consultation with a senior manager within the employing organisation.

Where it is not possible to reduce the threat to an acceptable level, an accountant should refuse to remain associated with information they consider is or may be misleading.

8 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Calculate fixed and variable costs by using high-low points method
- Calculate fixed and variable costs by using regression analysis
- Calculate profit using total absorption costing and marginal costing and explain the difference
- Explain the difference between traditional volume based absorption methods and activity-based costing
- Apportion overheads using activity-based costing
- Estimate unit cost using activity-based costing
- Discuss ethical issues in performance management and compliance with ICAN's Code of Ethics

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

Operating statements can be prepared as follows:

	MC	TAC
Sales (18,000 × ₦35)	630,000	630,000
Cost of sales		
MC = (18,000 × ₦8)	(144,000)	
TAC = (18,000 × ₦14)		(252,000)
Fixed production cost	(120,000)	
	366,000	378,000

The profit figures are reconciled as follows:

	Units
Opening inventory	2,000
Closing inventory	(4,000)
Increase	2,000
Difference in cost per unit	₦6
	₦12,000

	₦
MC profit	366,000
Inventory valuation difference	12,000
TAC profit	378,000

Solutions **2**

a) Marginal cost profit statement.

	Units	Per unit (₦)	₦000
Sales (balancing figure)	26,000	50	1,300
Cost of sales			
Opening inventory	2,000	30	60
Actual production	25,500	30	765
Closing inventory	(1,500)	30	(45)
	26,000	30	(780)
Fixed costs (25,000 × ₦4)			(100)
			420

Alternatively:

	₦000
Marginal cost profit statement.	₦000
Sales (26,000 units × ₦50)	1,300
Variable production costs (26,000 × ₦30)	(780)
Fixed costs (25,000 × ₦4)	(100)
Marginal cost profit	420

Solutions (continued) **2**

b) Absorption cost profit statement

	Units	Per unit (₦)	₦000
Sales	26,000	50	1,300
Cost of sales			
Opening inventory	2,000	34	68
Actual production			
Variable production costs	25,500	30	765
Fixed production costs Over	25,500	4	102
absorption	(500)	4	(2)
			865
Closing inventory	(1,500)	34	(51)
	26,000	34	(882)
			418

Alternatively:

b) Absorption cost profit statement

	₦000
Sales (26,000 units × ₦50)	1,300
Variable costs (26,000 × ₦30)	(780)
Fixed costs (26,000 × ₦4)	(104)
Over absorption of fixed overhead (500 units × ₦4)	2
	418

The profit figures are reconciled as follows:

	Units
Opening inventory	2,000
Closing inventory	1,500
Decrease	500
Difference in cost per unit	₦4
	₦2,000

	₦
MC profit	420,000
Inventory valuation difference	(2,000)
TAC profit	418,000

Skills level
Performance management

CHAPTER 3

Modern management accounting techniques

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

A	**Cost planning and control**				
	2	**Cost planning and control for competitive advantage**			
		a	Discuss and apply the principles of:		
			i	Target costing;	
			ii	Life cycle costing;	
			iii	Theory of constraints (TOC);	
			iv	Throughput accounting;	
			v	Back flush accounting;	
			vi	Environmental accounting; and	
			vii	Kaizen costing.	

D	**Decision making**			
	1	**Advanced decision-making and decision-support**		
		c	Apply relevant cost concept to short term management decisions including …… product and segment profitability analysis, etc.	

Exam context

This chapter explains each of the above topics in turn.

By the end of this chapter, you should be able to:

- Describe target costing and how target cost is determined
- Apply the target costing tools to given scenarios
- Explain lifecycle costing
- Explain throughput accounting and solve throughput accounting problems
- Explain and apply backflush accounting
- Explain and apply environmental accounting
- Explain Kaizen costing
- Explain and calculate product profitability
- Explain and calculate segment profitability using full cost and contribution approaches

1 THE RELEVANCE OF TRADITIONAL MANAGEMENT ACCOUNTING SYSTEMS

Section overview

- The purpose of management accounting systems
- Are traditional management accounting methods still relevant?
- Kaplan: 'relevance lost'
- Problems with standard costing and variances
- The continuing relevance of standard costing systems
- Making management accounting relevant
- Trends in management accounting

1.1 The purpose of management accounting systems

A management accounting system is a part of the management information system within an organisation. The purpose of management accounting is to provide information to managers that can be used to help them with making decisions. Traditionally, management accounting systems have provided financial or accounting information, obtained from accounting records and other data within the organisation. Commonly-used management accounting techniques have included absorption costing, marginal costing and cost-volume-profit analysis, budgeting, standard costing and budgetary control and variance analysis.

For various reasons, questions have been raised about the relevance of traditional management accounting to the needs of management in the modern business environment.

- Traditional management accounting techniques such as standard costing and variance analysis do not provide all the information that managers need in manufacturing companies where Total Quality Management or Just in Time management approaches are used.
- Traditional absorption costing is probably of limited value in a manufacturing environment where production processes are highly automated, and production overhead costs is a much more significant element of cost than direct labour.
- Traditional management accounting focuses on manufacturing costs, whereas many companies (and other organisations) operate in service industries and provide services rather than manufactured products.
- The traditional focus of management accounting has been on cost control or cost reduction. Lower costs mean that lower prices can be charged to customers, or higher profits can be made. However, many companies now seek to increase customer satisfaction and meet customer needs. To meet customer needs, other factors in addition to cost can be important – particularly product (or service) quality. Traditional management accounting ignores factors such as quality, reliability or speed of service.

- Many traditional management accounting techniques have a short-term focus. There are exceptions. Discounted cash flow, for example, is used to evaluate long-term capital projects. However, traditional management accounting systems do not provide senior managers with the information they need for making strategic decisions. Strategic decision-making needs information about competitors, customers, developments in technology and other environmental (external) factors.

Management information systems should be capable of providing the information that managers need. For the management accounting system to be the main management information system within an organisation, it must be able to provide the necessary variety of information – financial and non-financial, long-term as well as short-term – using suitable techniques of analysis.

1.2 Are traditional management accounting methods still relevant?

Many businesses compete with each other on the basis of:

- product or service quality and price
- delivery
- reliability
- after-sales service
- customer satisfaction – meeting customer needs.

These are critical variables in competitive markets and industries. Business organisations, faced with an increasingly competitive global market environment, must be able to deliver what the customer wants more successfully than their rivals. This means making sure that they provide quality for the price, and customer satisfaction, including the delivery, reliability and after-sales service that customers want or expect.

1.3 Kaplan: 'relevance lost'

Some years ago, Robert Kaplan put forward an argument that management accounting systems had lost their relevance and did not provide the information that managers need to make their decisions.

He suggested that the information needs of management had changed, but the information provided by management accountants had not. There was a danger that management accounting would lose its relevance – and value – entirely.

Kaplan made the following criticisms of traditional management accounting systems:

- Traditional overhead costing systems, where overheads were absorbed into costs at a rate per direct labour hour, were irrelevant. (Activity based costing has been developed as just one alternative for overhead cost analysis.)
- Standard costing systems are largely irrelevant, because in many markets customers do not want to buy standard products. They want product differentiation.

- Traditional management accounting systems fail to provide information about aspects of performance that matter – product and service quality (and price), delivery, reliability, after-sales service and customer satisfaction.

He argued that in today's competitive market environment 'traditional cost accounting systems based on an assumption of long production runs of a standard product, with unchanging characteristics and specifications, [are not] relevant in this new environment.'

The need for a change of focus in providing information to management

Traditional management accounting systems focus on reducing costs and budgetary control of costs. Kaplan argued that the focus was wrong:

- In modern production systems, products are often designed and manufactured to specific customer demands and often have a short life cycle. Their design is often sophisticated, and they are overhead-intensive. Traditional management accounting systems, in contrast, assume standard products whose manufacture is directly labour-intensive.
- Machinery used in production is often flexible, and can be switched between different uses and purposes. Traditional manufacturing systems assume that standard tasks require particular types of machine. Although they may focus on minimising the machine time per product manufactured, these systems do not provide information to help with optimising the use of available multi-purpose machinery.

1.4 Problems with standard costing and variances

Kaplan and Johnson have argued that standard costing and standard cost variances should not be used in a modern manufacturing environment for either:

- cost control, or
- performance measurement.

They argued that standard costs are no longer relevant in a modern manufacturing environment. Standard costing is used for standard products and the focus is on keeping production costs under control.

Kaplan and Johnson argued that using variance analysis to control costs and measure performance is **inconsistent with a focus on the objectives of quality, time and innovation**, which are now key factors in successful manufacturing operations.

- Standard cost variances ignore quality issues and ignore quality costs. However, in a competitive market quality is a key success factor.
- When a company relies for success on innovation and new product design, many of its resources are committed to product design and development, and so many of its costs are incurred at this early stage of the product's life. Cost control should therefore focus on design and development costs, whereas standard costing provides information about production costs for products that have already been developed and are now in production.

- When product design and innovation are important, product life cycles will be short. It may therefore be appropriate to look at all the costs of a product over its full life cycle (including its design and development stages, and including marketing costs as well as production costs).
- Standard costing variance analysis is restricted to monitoring the manufacturing costs of products during just a part of their life cycle.
- Standard costs are only likely to apply in a stable and non-changing business environment. In many industries, the environment is continually changing, and products are adapted to meet the changing circumstances and conditions.

1.5 The continuing relevance of standard costing systems

However, there are still some **advantages** to be obtained from using a standard costing system.

- Standard costs can be a useful aid for budgeting even in a Total Quality Management environment. Standard costs can be established for making products within the budget period to a target level of quality. If the TQM goals of continuous improvement and elimination of waste are achieved, the standard costs can be adjusted down for the next budget period.
- Managers need short-term (‘real time’) feedback on costs. They need to know whether costs are under control, and they also need to understand the financial consequences of their decisions and actions. Variance analysis is a useful method of providing ‘real time’ feedback on costs.
- Cost control is still an important aspect of management control. Quality, time and innovation may be critical factors, but so too is cost control. Standard costing and variance analysis provides a system for controlling costs in the short term.
- Standard costs for existing products can provide a useful starting point for planning the cost for new products.
- Standard costs can also be useful for target costing. The difference between the target cost for a product and its current standard cost is a ‘cost gap’. Standard costs can be used to measure the size of the cost gap. In order to achieve the target cost, managers can focus on this cost gap and consider ways in which it can be closed.
- Overhead variances can provide useful information for cost control when many overhead costs are volume-driven.

1.6 Making management accounting relevant

If it is accepted that traditional management accounting systems are no longer relevant to the information needs of managers in a competitive business world, the obvious next question is what has to be done to make them relevant?

The suggested answer is that management accounting systems need to recognise the factors that are critical for business success that management need to know about. These factors may be:

- non-financial, as well as financial;

- longer-term (strategic) in nature, as well as short-term;
- strategic (concerned with objectives and strategies), as well as tactical (concerned with day-to-day management control); and
- related to factors in the business environment as well as to factors within the business entity itself (in other words, making use of external as well as internal information).

1.7 Trends in management accounting

New techniques have been developed in management accounting, in response to changes in the business environment.

Examples of techniques that have been developed include:

- target costing;
- life cycle costing;
- product profitability analysis;
- segment profitability analysis;
- throughput accounting;
- backflush accounting;
- activity based management; and
- balanced scorecard (covered in an earlier chapter)

Some of these techniques have been developed in response to changes in manufacturing methods and systems.

Evaluating a management accounting technique

Management accounting techniques used in practice will vary with the particular information needs of the organisation.

The management accounting techniques used within an organisation must provide information that management need and will use. The key questions to ask, when assessing the usefulness of a management accounting system, are as follows:

The information needs of management

What decisions do managers need to make?

What are the key factors that will affect their decisions?

What are the critical items of information they need for their decisions?

The information provided by the management accounting system

- Is the information provided:
  - **relevant** to the decision-making needs of the managers?
  - sufficiently **comprehensive** for these needs?
  - reliable?
  - available when needed?

- ❑ Is the information provided in a clear and understandable form?
- ❑ Are key items of information drawn to the attention of the manager, such as issues relating to **controllability**, **trend** or **materiality**?
- ❑ Does the benefit of having the information justify the cost of providing it?

2 TARGET COSTING

Section overview

- 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
- Comprehensive example

2.1 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.

2.2 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.

Illustration: Target cost

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.

2.3 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.

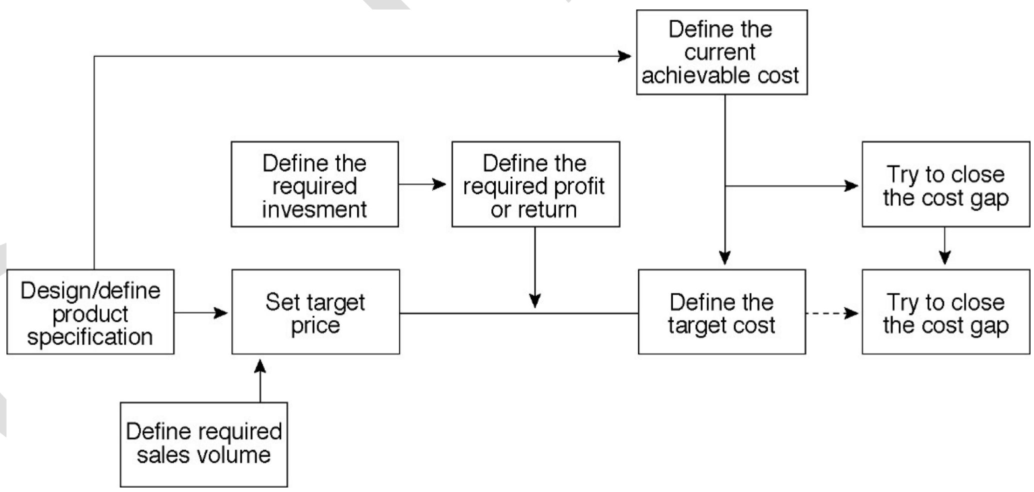
There may also be estimates of the capital investment required, and any incremental fixed costs (such as marketing costs or costs of additional salaried staff).

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.

Illustration: Target costing



2.4 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.

Example: Target costing

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.

Answer

		₦	₦
a)	**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
b)	**Target cost**		
	Sales price	70.0	
	Minimum gross profit margin (30%)	21.0	
	Target cost		49.0
c)	**Cost gap**		6.0

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

2.5 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.

2.6 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.

2.7 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.

2.8 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.

2.9 Comprehensive example

Example: Target costing

A company wishes to introduce a new product to the market.

The company estimates the market for the product to be 50,000 units.

The company uses target costing.

Current projected costs are as follows:

	₦'000
Manufacturing cost	
Bought in parts (100 components)	50,000
Direct labour (assembly of components) 10 hours × ₦500 per hour	5,000
Machine costs (750,000,000 ÷ 50,000)	15,000
Ordering and receiving (500 orders × 100 components × ₦500 per order) ÷ 50,000 units	500
Quality assurance (10 hours × ₦800 per hour)	8,000
Rework costs 10% (probability of failure) × ₦10,000 (cost of rework)	1,000
Non–manufacturing costs	
Distribution	10,000
Warranty costs 10% (probability of recall) × ₦15,000 (cost to correct)	1,500
	91,000
Target selling price (₦)	100,000
Target margin	20%
Target profit (₦)	20,000
Target cost (₦)	80,000

The company has undertaken market research which found that several proposed features of the new product were not valued by customers. Redesign to remove the features leads to a reduction in the number of components down to 80 components and a direct material cost reduction of 12%.

The reduction in complexity has other impacts:

1. Assembly time will be reduced by 20%.
2. Quality assurance will only require 6 hours.
3. The probability of a failure at the inspection stage will fall to 5%.
4. The probability of an after-sales failure will also fall to 5%.
5. Cost of warranty corrections will fall by ₦2,000.
6. Reduced weight of the product will reduce shipping costs by ₦1,000 per unit.

Example (continued): Target costing

The revised projected costs are as follows:

	Before	After
	₦'000	₦'000
Manufacturing cost		
Bought in parts (100 components)	50,000	
Bought in parts (80 components with 12% reduction)		44,000
Direct labour (assembly of components)		
10 hours × ₦500 per hour	5,000	
8 hours × ₦500 per hour (10% reduction)		4,000
Machine costs (750,000,000 ÷ 50,000)	15,000	15,000
Ordering and receiving		
500 orders × 100 components × ₦500 per order/50,000 units	500	
500 orders × 80 components × ₦500 per order/50,000 units		400
Quality assurance		
10 hours × ₦800 per hour	8,000	
6 hours × ₦800 per hour		4,800
Rework costs		
10% × ₦10,000	1,000	
5% × ₦10,000		500
Non–manufacturing costs		
Distribution	10,000	9,000
Warranty costs		
10% × ₦15,000	1,500	
5% × ₦13,000		650
	91,000	78,350

The target cost is achieved.

3 LIFE CYCLE COSTING

Section overview

- The nature of life cycle costing (LCC)
- Asset acquisitions
- Life cycle costing and building construction
- Life cycle costing and the product life cycle

3.1 The nature of life cycle costing (LCC)

Life cycle costing is sometimes called 'whole life costing' or 'whole life cycle costing'. It is a technique that attempts to identify the total cost associated with the ownership of an asset so that decisions can be made about asset acquisitions. It recognises that decisions made at the initial acquisition have the effect of locking in certain costs in the future.

The principles of LCC can be applied to both complex and to simple acquisitions.

- As a simple example if a person buys a new printer that person is committed to buying toner cartridges that are compatible to the printer. Thus in choosing between two printers the initial cost of one might be less than the other but its toner cartridges might be more expensive. Life cycle cost analysis would allow a choice to be made based on the total life time costs.
- A company will of course be concerned with cost when it buys a complex asset of some kind but it will also be concerned with reliability, servicing time, maintenance costs etc.

Life cycle costing can be applied to:

- Major asset acquisitions.
- Introduction of new products to the market.

3.2 Asset acquisitions

The cost of ownership of an asset is incurred throughout its life and not just at acquisition. A decision made at the purchase stage will determine future costs associated with an asset.

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.

Example: Life cycle costing

A transport company wishes to buy a new heavy goods vehicle which will be run for 100,000 miles and then sold.

It is considering two types.

The following information is relevant:

	Lorry A	Lorry B
Initial cost	₦10,000,000	₦15,000,000
Cost per service	₦500,000	₦400,000
Service required every:	10,000 miles	25,000 miles
Running costs per mile	₦750	₦500
Scrap value at end of life	₦1,000,000	₦3,000,000

The life cycle cost of each lorry based on the above is as follows:

	₦	₦
Capital cost:		
Initial cost	10,000,000	15,000,000
Scrap value	(1,000,000)	(3,000,000)
	9,000,000	12,000,000
Service costs		
Life time use (miles)	100,000	100,000
Service frequency (miles)	10,000	25,000
Number of services	10	4
Cost per service	500,000	400,000
	5,000,000	1,600,000
Running costs		
Number of miles	100,000	100,000
Cost per mile (₦)	750	500
	75,000,000	50,000,000
Lifecycle cost	89,000,000	63,600,000

Life cycle costing methodology

A proper purchasing decision requires that the costs of all available options should be taken into account. This involves cost identification and estimation and discounting. (Discounting is a technique that takes into account the time value of money. That is to say it recognises that ₦1 today is worth more than ₦1 in the future).

Benefits of LCC include:

- Improved evaluation of options
- Improved management awareness about the consequences of decisions
- Improved forecasting
- Improved understanding of the trade off between performance of an asset and its cost.

Problems with using LCC

- Availability of data
- It is difficult and time consuming
- Often organisations are structured in a way that different managers are responsible for the purchase decision and the future operation of the asset. Thus, even though the purchase decision locks in future costs the manager making the acquisition has no incentive to consider LCC.

3.3 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.

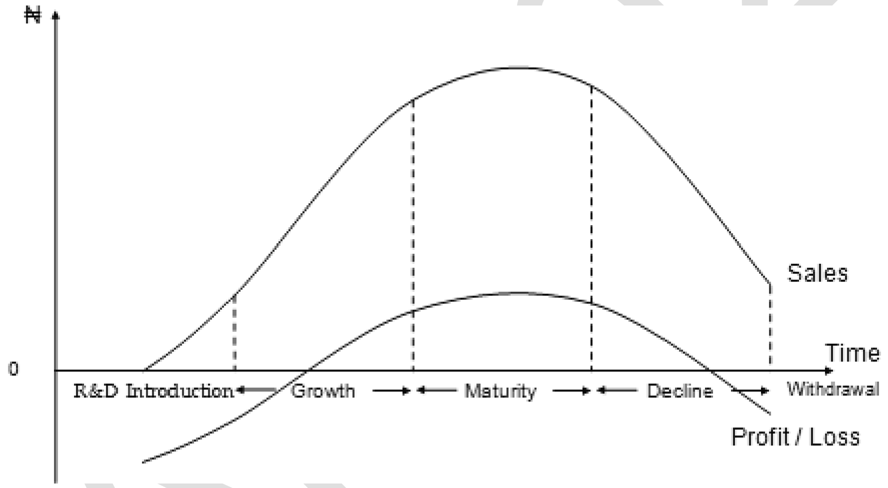
3.4 Life cycle costing and the product life cycle

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

- product development stage
- product introduction to the market
- a period of growth in sales and market size
- a period of maturity
- a period of decline.
- withdrawal from the market.

The diagram below indicates typical characteristics of sales revenue and profit at each stage.

Illustration: Product life cycle



At each phase of a product's life cycle:

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

LCC can be important in new product launches as a company will of course want to make a profit from the new product and the technique considers the total costs that must be recovered. These will include:

- research and development costs;
- training costs;
- machinery costs;
- production costs;
- distribution and selling costs;

- marketing costs;
- working capital costs;
- retirement and disposal costs.

Decisions made at the development phase impact later costs.

Stage	Costs
Product development	R&D costs Capital expenditure decisions
Introduction to the market	Operating costs Marketing and advertising to raise product awareness (strong focus on market share) Set up and expansion of distribution channels
Growth	Costs of increasing capacity Maybe learning effect and economies of scale Increased costs of working capital
Maturity	Incur costs to maintain manufacturing capacity Marketing and product enhancement costs to extend maturity
Decline	Close attention to costs needed as withdrawal decision might be expensive
Withdrawal	Asset decommissioning costs Possible restructuring costs Remaining warranties to be supported

Benefits of LCC

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.

4 THROUGHPUT ACCOUNTING

Section overview

- 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
- Constraints and bottlenecks in the system
- Dealing with constraints
- The relevance of constraints to throughput accounting
- Performance measurement ratios in throughput accounting

4.1 The nature of throughputaccounting

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 with the Theory of Constraints. This is a theory that states that 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:

Contribution = 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: Profit and throughput accounting

	₦
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 inventories are therefore valued at the cost of 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: Comparing throughput accounting with absorption costing and marginal costing

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.

Example (continued): Comparing throughput accounting with absorption costing and marginal costing

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

	Absorption costing	Marginal costing	Throughput accounting
Sales	32,000	32,000	32,000
Production costs			
Raw materials	6,000	6,000	6,000
Direct labour	8,000	8,000	
Fixed overhead	10,000		
	24,000	14,000	6,000
Closing inventory $\times {}^{200}/_{1,000}$	(4,800)	(2,800)	(1,200)
Cost of sale	(19,200)	(11,200)	(4,800)
Gross profit	12,800		
Contribution		20,800	
Throughput contribution			27,200
Less operating expenses			
Other non-production overheads	5,000	5,000	5,000
Fixed overheads		10,000	10,000
Labour costs			8,000
	(5,000)	(15,000)	(23,000)
Net profit	7,800	5,800	4,200

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

4.7 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.

4.8 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, 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.

4.9 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.

4.10 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

Formula: Return on investment

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

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:

Formula: Throughput productivity

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

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:

Formula: Throughput accounting ratio

$$= \frac{\text{Throughput per hour of bottleneck resource}}{\text{Operating expenses per hour of bottleneck resource}} \times 100$$

Example: Throughput accounting ratio

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

Operating expenses per machine hour = ₦120,000/600 hours = ₦200

Throughput accounting ratio = ₦240/₦200 = 1.2

(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 BACKFLUSH ACCOUNTING

Section overview

- JIT production and JIT purchasing
- Introduction to backflush accounting
- Backflush accounting with two ‘trigger points’
- Backflush accounting with one ‘trigger point’

5.1 JIT production and JIT purchasing

Just-in-Time (JIT) management methods originated in Japan in the 1970s. The principle of JIT is that producing items for inventory is wasteful, because inventory adds no value, and holding inventory is therefore an expense for which there is no benefit.

If there is no immediate demand for output from any part of the system, a production system should not produce finished goods output for holding as inventory. There is no value in achieving higher volumes of output if the extra output goes into inventory that has no immediate use.

Similarly, if there is no immediate demand for raw materials, there should not be any of the raw materials in inventory. Raw materials should be obtained only when they are actually needed.

It follows that in an ideal production system:

- there should be no inventory of finished goods: items should be produced just in time to meet customer orders, and not before (**just in time production**)
- there should be no inventories of purchased materials and components: purchases should be delivered by external suppliers just in time for when they are needed in production (= **just in time purchasing**).

Definition

Just-in-time purchasing is a purchasing system in which material purchases are contracted so that the receipt and usage of the materials, to the maximum extent, coincide

(CIMA Official Terminology).

5.2 Introduction to backflush accounting

Backflush accounting is a method of cost accounting that is consistent with JIT 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.
- 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'.
- With a JIT philosophy, this benefit does not exist. 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.
- Backflush accounting is an alternative costing system that can be applied in a JIT environment. It is ideally suited to a manufacturing environment where production cycle times are fairly short and inventory levels are low.

As the term 'backflush' might suggest, 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.

It is important to recognise that the great advantage of backflush accounting is that costs can be worked 'backwards', after the goods have been produced and sold. There is no need for a complex cost accounting system that records costs of production sequentially.

5.3 Backflush accounting with two 'trigger points'

An event that leads to the recognition of costs is called a trigger point.

A backflush accounting system has one or two trigger points, when costs are recorded. When there are two trigger points, these are usually:

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

Trigger point 1

Direct material costs and other direct production costs are recorded in the usual way by debiting the costs to the appropriate account. It is helpful to think of these accounts as being like expense accounts where the costs are held until they can be included into the cost of sales and to a much lesser extent into closing inventory.

Trigger point 2

The cost of production is debited into finished inventory when production is complete. The credit entries are to the suspense accounts at standard costs.

Balances on the suspense accounts after these entries represent closing inventory of finished goods or cost variances.

The debit recognised in the finished inventory account moved to a cost of goods sold account almost immediately (remember what just in time manufacture means).

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

Example: Backflush accounting

A manufacturing company makes a single 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
Conversion costs:	
Direct labour costs incurred	₦775,000
Overhead costs incurred	₦2,260,000
	₦3,035,000

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

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

Trigger point 1: Record the purchase of raw materials

Debit: Raw materials inventory	₦2,030,000
Credit: Creditors/payables	₦2,030,000

Other conversion costs are also recorded

Debit: Conversion costs	₦3,035,000
Credit: Creditors/payables	₦3,035,000

Raw materials inventory account

	₦		₦
Creditors	2,030,000		

Conversion costs account

	₦		₦
Bank (labour cost)	775,000		
Creditors (overheads)	2,260,000		
	3,035,000		

Example (continued): Backflush accounting

Trigger point 2: Record the manufacture of the 100,000 units

Finished goods inventory account

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

Raw materials inventory account

	₦		₦
Creditors	2,030,000	Finished goods inventory	2,000,000
		Closing balance c/f	30,000
	2,030,000		2,030,000

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 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 the income statement for the period.

Similarly, the balance on the conversion costs account represents cost variances for labour and overhead, and this should be written off to the income statement for the period.

Almost immediate recognition of cost of sales

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

Finished goods inventory account

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

5.4 Backflush accounting with one 'trigger point'

An even simpler backflush accounting system has just one trigger point, the manufacture of finished units. In this system, the purchase of direct materials is not recorded.

Conversion costs are debited, initially to a suspense account (or accounts as before).

The cost of production is debited into finished inventory when production is complete with the credit entries are to the suspense accounts at standard costs and to payables for raw materials.

Example: Backflush accounting

A manufacturing company makes a single product (P), which has the following standard cost:

	₦
Raw materials	20
Conversion costs	30
	50

During the period, it incurred the following costs:

Raw materials purchased	₦2,030,000
Conversion costs:	₦3,035,000

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

The company uses a backflush costing system trigger point at completion of production.

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

Finished goods inventory account

	₦		₦
Raw materials (payables) (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

The only difference is that 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.

6 ENVIRONMENTAL ACCOUNTING

Section overview

- The purpose of environmental management accounting
- A framework for environmental management accounting
- EMA techniques

6.1 The purpose of environmental management accounting

For some companies, environmental issues are significant, in terms of both strategy and cost.

- Poor environmental behaviour can result in significant costs or losses, such as fines for excessive pollution, environmental taxes, loss of land values, the cost of law suits, and so on.
- Environmental behaviour can affect the perception of customers, and their attitudes to a company and its products. Increasingly, consumers take environmental factors into consideration when they make their buying decisions.

Environmental management accounting can be used to provide information to management to help with the management of environmental issues. Traditional management accounting techniques can:

- under-estimate or even ignore the cost of poor environmental behaviour;
- over-estimate the costs of improving environmental practices; and
- under-estimate the benefits of improving environmental practices.

Environmental management accounting (EMA) provides managers with financial and non-financial information to support their environmental management decision-making. EMA complements other 'conventional' management accounting methods, and does not replace them.

The main applications of EMA are for:

- estimating annual environmental costs (for example, costs of waste control);
- budgeting;
- product pricing;
- investment appraisal (for example, estimating clean-up costs at the end of a project life and assessing the environmental costs of a project); and
- estimating savings from environmental projects.

6.2 A framework for environmental management accounting

Burritt et al (2001) suggested a framework for EMA based on providing information to management:

- from internal or external sources;

- as monetary or physical measurements;
- as historical or forward-looking information;
- where the focus is short-term or longer-term;
- that consists of routine reports or ad hoc information.

Four of these elements of EMA are shown in the following table:

Environmental management accounting (EMA)

		Monetary EMA		**Physical EMA**	
■		**Short-term focus**	**Long-term focus**	**Short-term focus**	**Long-term focus**
■ *Historical orientation*	■ Routine reporting	■ Environmental cost accounting	■ Analysis of environmentally-induced capital expenditures	■ Material and energy flow accounting	■ Accounting for environmental capital impacts
	■ Ad hoc (one-off) information	■ Historical assessment of environmental decisions	■ Environmental life cycle costing, environmental target costing	■ Historical assessment of short-term environmental impacts, e.g. of a site or product	■ Post-investment assessment of environmental impacts of capital expenditures
■ *Future orientation*	■ Routine reporting	■ Environmental operational budgets and capital budgets (monetary	■ Environmental long-term financial planning	■	■ Environmental long-term physical planning
	■ Ad hoc (one-off) information	■ Relevant environmental costing (e.g. special orders)	■ Environmental life cycle budgeting and target costing	■ Assessment of environmental impacts	■ Physical environmental investment appraisal. Specific project life cycle analysis

6.3 EMA techniques

Environmental management accounting techniques include:

- re-defining costs;
- environmental activity-based accounting; and
- environmental life cycle costing.

Re-defining costs

The US Environmental Protection Agency (1998) suggested terminology for environmental costing that distinguishes between:

- **conventional costs**: these are environmental costs of materials and energy that have environmental relevance and that can be 'captured' in costing systems;
- **potentially hidden costs**: these are environmental costs that might get lost within the general heading of 'overheads';
- **contingent costs**: these are costs that might be incurred at a future date, such as clean-up costs;
- **image and relationship costs**: these are costs associated with promoting an environmental image, such as the cost of producing environmental reports. There are also costs of behaving in an environmentally irresponsible way, such as the costs of lost sales as a result of causing a major environmental disaster.

In traditional management accounting systems, environmental costs (and benefits) are often hidden. EMA attempts to identify these costs and bring them to the attention of management.

Environmental activity-based accounting

Environmental activity based accounting is the application of environmental costs to activity based accounting. A distinction is made between:

- environmental-related costs: these are costs that are attributable to cost centres involved in environmental-related activities, such as an incinerator or a waste recycling plant;
- environmental-driven costs: these are overhead costs resulting from environment-related factors, such as higher costs of labour or depreciation.

The cost drivers for environment-related costs may be:

- the volume of emissions or waste;
- the toxicity of emissions or waste;
- 'environmental impact added' (units multiplied by environmental impact per unit); or
- the volume of emissions or waste treated.

Environmental life cycle costing

Life cycle costing is a method of costing that looks at the costs of a product over its entire life cycle. Life cycle costing can help a company to establish how costs are likely to change as a product goes through the stages of its life (introduction, growth, maturity, decline and withdrawal from the market). This analysis of costs should include environmental costs.

Illustration: Environmental life cycle costing

Xerox provides a good example of the environmental aspect of life cycle costing. Xerox manufactures photocopiers, which it leases rather than sells. At the end of a lease period, the photocopiers are returned from the customer to Xerox.

At one time, photocopiers were delivered to customers in packaging that could not be re-used for sending the machines back at the end of the lease period.

Customers disposed of the old packaging and had to provide their own new packaging to return the machines to Xerox. Xerox then disposed of this packaging.

The company therefore incurred two costs: the cost of packaging to deliver machines and the cost of disposal of the packaging for returned machines.

By looking at the costs of photocopiers over their full life cycle, Xerox found that money could be saved by manufacturing standard re-usable packaging. The same packaging could be used to deliver and return machines, and could also be re-used.

At the same time, the company created benefits for the environment by reducing disposals of packaging materials.

7 KAIZEN COSTING

Section overview

- An introduction to Kaizen costing
- Techniques for continuous improvement
- Kaizen costing compared with standard costing

7.1 An introduction to Kaizen costing

For companies that practise TQM and continuous improvement methods, Kaizen costing takes over where target costing ends.

- Target costing is used in the design and development stage for a new product.
- Kaizen costing is applied from the time that a product goes into full production until the end of the product's life.

Taken together, target costing and Kaizen costing are systems for life cycle costing.

The philosophy of continuous improvement (Kaizen) is based on the view that markets are highly competitive and industry must try to keep reducing costs in order to reduce selling prices in order to maintain a competitive advantage. Kaizen costing is a management accounting system that provides cost information to help with achieving improvements without loss of product quality or value.

Most of the costs of a product over its entire life cycle are committed during the design and development stage. This is why target costing is a valuable technique for the control of costs (without loss of value). However, there is still some scope for further cost reduction after commercial production and marketing of the product has begun.

A Kaizen costing system is therefore a costing system that is designed to help a company to reduce product costs.

- A target for cost reductions is set. This target is below the current cost. The cost reduction must be achieved without any loss of value for the customer. For example, a target might be set to reduce unit costs of production by 5% within two years.
- Teams are established to identify methods of making improvements.
- Kaizen focuses on making small improvements, as it is unlikely that a single improvement will be sufficient to achieve the target cost reductions. Many different improvements might be needed over a period of time.
- Actual costs are continually compared with the target costs, and progress towards achieving the target cost is monitored through regular reporting.
- The project teams must continually review production conditions to find ways of making more improvements and more cost reductions.
- Normally, teams are rewarded with bonuses if they achieve their cost reduction targets.

- When one cost reduction target is met, another cost reduction target takes its place. With Kaizen, the process of seeking improvements never ends.

7.2 Techniques for continuous improvement

Teams that are given the responsibility for making improvements might use value analysis (VA) methods. VA is similar to value engineering, except that VA is applied to existing products and VE to products during their design and development stage.

The types of questions that might be asked are as follows:

- Can common materials and parts be used? The same part might be used in two or more parts of the product, or the same part might be used for several different products that the company manufactures.
- How much of the cost consists of purchased materials and components? Can major suppliers be persuaded to reduce their own costs and prices?
- Can improvements be made in logistics (distribution) or packaging?
- Can the investment in the product (for example, working capital) be reduced?
- Can improvements be made in production systems or maintenance methods?
- Can the work be organised in a different way?
- A system of value analysis must be supported by a management accounting system that provides relevant cost data.

7.3 Kaizen costing compared with standard costing

It is useful to compare Kaizen costing with traditional standard costing.

- With standard costing, expected costs are established based on current production methods. Variances between actual and standard costs are calculated, and variance reports focus on significant variations between actual costs and the current standard. There is no motivation to make improvements and reduce costs below the existing standard.
- With Kaizen costing, actual costs are compared with the target, not an existing standard. The variance reporting system is used to monitor progress towards the target cost.
- With standard costing, managers are encouraged to prevent adverse variances. For example, if there is an adverse material price variance, the manager responsible might decide to buy materials at a lower price from a different supplier. The result could be a loss of quality, a fall in value and a reduction in customer satisfaction.
- With Kaizen costing, reductions in cost must be achieved without any loss of value.

A 1993 article on Kaizen and Kaizen costing concluded: ‘In the US, changes in the focus and methods of production need to be accompanied by changes in management accounting systems. The Japanese have provided guidance on how management accounting can play a significant role in creating sustainable competitive advantage for a firm. The more organisations rid themselves of traditional management accounting practices, the better is the chance that the new ideas about manufacturing can take over and really show their worth. Old ways of product costing blunt a firm's ability to compete effectively and hinder their ability to focus on world-class performance.'

8 PRODUCT PROFITABILITY ANALYSIS

Section overview

- Introduction
- Direct product profitability
- Problems with DPP

8.1 Introduction

It would be very unusual to find a company with a single product. Many companies have wide product ranges.

Manufacturing companies often have complex costing systems to establish the cost of production. Traditional accounting systems identify the direct costs associated with a product and incorporate systems to apportion production overheads into cost units. More modern techniques are discussed elsewhere in this chapter. If cost allocation is reliable it is relatively helpful.

8.2 Direct product profitability

Retailers know how much units of inventory have cost them and how much they are sold for. However, simply understanding the gross margin of different products does not always indicate the true profitability of those products.

A retailer might be interested in understanding the impact that sales of individual products and product lines have on profitability. Direct product profitability (an approach developed by McKinsey & Co) is a technique which allows them to do this. Direct product profitability attempts to attribute the purchase price and indirect costs to individual products and product lines. This allows the identification of a net profit for each of these.

Illustration: Direct product profitability

Direct product profitability of a given product for a given period is found as follows.

		₦
Sale revenue		X
Purchase price (net of discounts received)		(X)
Gross profit		X
Less:		
Ordering costs	X	
Storage costs	X	
Distribution costs	X	
Cost of obsolescence	X	
		(X)
Direct product profit		X

Notice that direct product profitability is expressed in profit per period rather than per unit. Looking at unit profitability might be misleading as it would fail to take sales volumes into account.

Example: Direct product profitability

A retailer sells two products (A and B) as follows:

	A	B
Sales price	₦4,000	₦3,000
Purchase cost	₦3,000	₦2,000
Gross profit per unit	₦1,000	₦1,000
Gross margin	25%	33.33%
Shelf space per unit	20 cm^2	10 cm^2
Gross profit per unit of cm^2 of shelf space	₦50	₦100

It looks as if the retailer should be concentrating on selling B from the above information. However, further data for weekly performance shows that this is not the case.

	A	B
Gross profit per unit	₦1,000	₦1,000
Unit sales	400	20
Gross profit	₦400,000	₦20,000
Area used (cm^2)	2,000 cm^2	1,000 cm^2
Cost per cm^2 per week	₦50	₦50
Storage cost	₦100,000	₦50,000
Direct product profit	₦300,000	₦(30,000)

Information about DPP implies that it is not worth selling B.

This assumes that the space currently used to sell B could be used to sell more A. If this were not the case then the decision might be ill founded as B is making a contribution towards the storage costs.

In practice, large retailers will have many hundreds (thousands) of product lines. The space freed up from the discontinuation of a product line would always be used to sell something else.

The above example demonstrates the importance of obtaining sufficient information before meaningful analysis can be carried out.

DPP can be useful for a company that adopts a product based approach to marketing. It suggests better results can be achieved by selling more of the products which generate the highest product profitability.

DPP analysis suggests ways of improving product profitability. For example, moving items to more prominent positions to increase turnover or reducing the size of product packaging. It might also be used to justify retailers seeking product support from suppliers.

8.3 Problems with DPP

It depends on cost allocation and this might be difficult in practice.

It can be said to provide an incorrect marketing focus as it disregards the needs of the customers.

9 SEGMENT PROFITABILITY ANALYSIS

Section overview

- Introduction to segmental profitability analysis
- Full cost approach
- Segment contribution approach
- Comparison of the two approaches

9.1 Introduction to segmental profitability analysis

All businesses exist to make profit. They do this by producing goods and services and selling them for more than the cost of their production. The ability to measure performance in terms of profitability is very important.

It is highly unlikely that a business will have only one product. Single product businesses are useful to illustrate accounting principles but exist only in theory. Many companies have hundreds of products which they sell in many regions.

Given the existence of many products and many different areas of operations, it is unlikely that all products or areas will be profitable over time. Companies need to evaluate profit performance systematically and regularly on a segmental basis and unprofitable segments should be discontinued if they cannot be made profitable.

A business can segment its operations in several ways, including:

- by product line;
- by geographical area (town, district, country)

There are two main ways of measuring segment profitability:

- the full cost approach; and
- the contribution approach.

9.2 Full cost approach

The full cost approach attempts to measure the total profit earned by each segment.

The basic principles of this approach are as follows:

- The objective is to measure net profit of each operating segment.
- Overall net profit of a business is the sum of the net profit of the individual segments.

- All indirect expenses (common) must be allocated.
- Allocation of indirect expenses involves selecting bases of allocation.

Illustration: Segmental profit

	₦
Segment sales	X
Direct expenses	
Variable segment costs	(X)
Fixed segment expenses	(X)
	X
Allocated indirect expenses	(X)
	X

At first sight, this might look like a logical approach as a business cannot be successful without profit (net income). However, measuring the profit of a segment is more difficult than measuring the profit of a business in its entirety due to the need to identify segment expenses.

From the segment's point of view, there are two types of expenses:

- segment direct expenses; and
- segment indirect expenses.

Segment direct expenses

These are segment expenses that result from the existence and operation of the segment. These expenses would be avoided by a company if it closed the segment.

Examples of segment direct expenses include the following:

- direct costs (material, labour and variable overhead); and
- fixed costs that relate directly to a segment (e.g. factory rental).

Segment indirect expenses

These are segment expenses that are not directly caused by a particular segment. They relate to the company as a whole but are shared to the segments to which they relate in order to calculate segment profitability. These expenses would not be avoided by a company if it closed the segment.

Examples of indirect expenses include the following:

- directors' remuneration;
- head office expenses;
- costs of central functions (e.g. accounting, treasury, human resources etc.)

There are different methods that might be used for allocating expenses so it might be said that the final allocation is somewhat arbitrary. An unfair allocation method can cause one segment to appear to be more profitable than another when in fact this is not the case.

9.3 Segment contribution approach

The segment contribution approach attempts to measure the contribution made by each segment.

The basic principles of this approach are as follows:

- ❑ Only the contribution of each segment is computed. No attempt is made to compute the net income of the segment.
- ❑ Indirect or common expenses of each segment are not allocated.
- ❑ Indirect or common expenses, however, are usually deducted from total segmental contribution in order to arrive at overall business net income.

A segment is considered profitable if sales of the segment exceed the direct expenses of the segment

Illustration: Segmental contribution

	₦
Segment sales	X
Direct expenses	
Variable segment costs	(X)
Fixed segment expenses	(X)
	X

The major problem of the full cost approach is that it is possible for a segment to show an operating loss yet at the same time be making a positive contribution to net income. In other words, if the seemingly unprofitable segment is closed, then the overall net income of the business will decrease. This will be examined later in this chapter.

To overcome this adverse feature of the full cost approach, many businesses prefer to use the contribution approach to measuring segmental profitability.

The segmental contribution approach as indicated by its name measures segmental contribution. Segmental contribution may simply be defined as sales less direct expenses.

There is a difference between segmental contribution and contribution as discussed in earlier chapters.

- ❑ Contribution (as discussed in earlier chapters) is sales less variable expenses.
- ❑ Segmental contribution is segment sales less segment direct costs. Segment direct costs might include fixed costs. This is because they would vary if the segment was closed.

9.4 Comparison of the two approaches

The indirect expenses of a segment will continue to be incurred regardless of whether the segment is continued or not continued.

Therefore, as long as the segment is making a contribution towards indirect fixed expenses, continuing operations at least in the short run makes the business better off.

The following example illustrates the basic principles of the full cost and segmental contribution approaches.

Example: Segment profitability

A company operates as two segments (X and Y).

The following results relate to the most recent accounting period.

	X	Y	Total
	₦000	₦000	₦000
Sales	300	200	500
Direct costs	(215)	(170)	(385)
Segmental contribution	85	30	115
Indirect costs	(60)	(40)	(100)
Segmental profit/(loss)	25	(10)	15

Analysis

The full cost approach shows that segment Y is operating at a net loss of ₦10,000. This makes it look as if the business would be better off by ₦10,000 if it were to close segment Y.

The segmental contribution approach shows that segment Y is making a contribution of ₦30,000.

The contribution approach shows that segment Y actually makes a contribution to the total fixed costs. If segment Y were closed this contribution would be lost but the indirect costs would not be avoided. Therefore, the company would be ₦30,000 worse off if segment Y were closed and this would result in the company making a loss of ₦15,000.

10 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Describe target costing and how target cost is determined
- Apply the target costing tools to given scenarios
- Explain lifecycle costing
- Explain throughput accounting and solve throughput accounting problems
- Explain and apply backflush accounting
- Explain and apply environmental accounting
- Explain Kaizen costing
- Explain and calculate product profitability
- Explain and calculate segment profitability using full cost and contribution approaches

Skills level
Performance management

CHAPTER 4

Learning and experience curve theory

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

A	**Cost planning and control**			
	2	**Overview of costs for planning and control**		
		B	Learning and experience curve theory	
			i	Discuss and apply the learning and experience curve theory to pricing, budgeting and other relevant problems.
			ii	Calculate and apply learning rate to cost estimation.

Exam context

This chapter explains each of the above topics in turn.

By the end of this chapter, you should be able to:

- Explain the learning effect
- Use a tabular approach to illustrate the learning effect
- Use the learning effect formula to calculate time required for units at a given point in production as a basis for budgeting and pricing

1 THE LEARNING CURVE

Section overview

- The learning effect
- The learning curve model (tabular approach)
- Formula for the learning curve

1.1 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 learning 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;
- budgeting/forecasting production requirements and production costs; and
- 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

1.2 The learning curve model (tabular approach)

The learning effect can be measured mathematically, and shown as a learning curve.

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 learning effect

When there is a x% 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 x% of what it was before. For example:

- when there is an 80% learning curve, every time output doubles the cumulative average time to produce units falls to 80% of what it was before.
- The **cumulative average time per unit** is the average time for all the units made so far, from the first unit onwards. For example if an 80% learning effect applies:
  - the average time for the first two units is 80% of the average time for the first unit;
  - The average time for the first four units is 80% of the average time for the first two units and so on.

Example: The learning effect

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.

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.

These can be found by constructing the following table:

Total units (cumulative)	Cumulative average time per unit (days)	Total time for all units (days)	Incremental time for additional units (days)	Average time for additional units (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

Practice question **1**

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?

Calculate:

(a) the cumulative average time per unit for the first 2 units, first 4 units, first 8 units and first 16 units.

(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.

(d) the average time required to make the second unit, the 3rd and 4th units, units 5 – 8 and units 9 – 16.

Problem with the tabular approach

It is easy to construct a table to show the learning effect and it provides useful information. However, it can only be constructed to show doubling of the output.

The table can be used to calculate how many days it would take to construct units 3 and 4 and the average time for each of these. However, it cannot be used to calculate how long unit 3 actually took and how long unit 4 actually took. (We know that boats 3 and 4 together took 96 days to make but not how long each took as the learning effect means that boat 4 would have taken less time than boat 3).

Similarly, the table can be used to calculate how many days it would take to construct units 5 to 8 and the average time for each of these. However, it cannot be used to calculate how long unit 5 actually took and how long unit 7 (say) actually took. (We know that boats 5 to 8 together took 153.6 days to make but not how long each took as the learning effect means that boat 8 would have taken less time than boat 5 for example).

The way around this is to use the learning curve formula.

1.3 Formula for the learning curve

The learning curve is represented by the following formula (mathematical model):

Formula: Learning curve

$$y = ax^b$$

$$b = \frac{\text{log of learning rate}}{\text{log 2}}$$

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.

The learning rate is expressed as a decimal – a learning rate of 80% is expressed as 0.8

Logarithms (usually shortened to log) are different way to express a number. Logs can have different bases. The most widely used logs are $\log_{10}$ (log to the base 10 usually written simple as log) or natural logs (log to the base e but written as written as ln).

The log of a number is number of times that you would have to multiply 10 by itself to get that number. For example:

- the log of 100 is 2 meaning that you would have to multiply 10 by itself twice to get a hundred.
- the log of 1,000 is 3 meaning that you would have to multiply 10 by itself three times to get a thousand.
- the log of 80 is 1;90301 meaning that you would have to multiply 10 by itself 1;90301 times to get 80.
- the log of 0.8 is –0.9691 meaning that you would have to multiply 10 by itself –0.9691 times to get 0.8. (Note that the log of any number less than 1 is always negative).

Admittedly, this can be a little difficult to understand but modern calculators can calculate log values easily.

The learning effect can be computed using the formula approach thus:

$Y = ax^b$

Where the above variables are explained above.

$Y(x) = (ax^b)\ x$

$$b = \frac{\sqrt{Y(x)}}{\sqrt{(axb)x}}$$

Example:

Determine the learning rate of a process where the first unit (a) uses 720 hours and and the fourth unit is estimated to use an average of 405 hours per unit at a constant learning rate.

Solution :

Using the formula approach:

$Y = ax^b$

$$\text{Rate of learning} = \frac{\sqrt{y\,x}}{\sqrt{ax^b x}} = \frac{\sqrt{405} \times 4}{\sqrt{720} \times 4}$$

$$\sqrt{0.5625} = 0.75 = 75\%$$

Example (continued): The learning effect

Returning to the earlier 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.

The cumulative average time per unit for the first 2 units, first 4 units, first 8 units and first 16 units of the boat can be calculated as follows:

The learning factor:

$$b = \frac{\log \text{ of learning rate}}{\log 2} \qquad b = \frac{\log 0.8}{\log 2} = -0.32193$$

First 2 units

$$y = ax^b \qquad y = 100 \text{ days} \times 2^{-0.32193} = 80 \text{ days}$$

First 4 units

$$y = ax^b \qquad y = 100 \text{ days} \times 4^{-0.32193} = 64 \text{ days}$$

First 8 units

$$y = ax^b \qquad y = 100 \text{ days} \times 8^{-0.32193} = 51.2 \text{ days}$$

First 16 units

$$y = ax^b \qquad y = 100 \text{ days} \times 16^{-0.32193} = 40.96 \text{ days}$$

The formula can be used for any number of units.

Example (continued): The learning effect

Returning to the earlier 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.

The cumulative average time per unit for the first 9 units is as follows:

The learning factor:

$$b = \frac{\log \text{ of learning rate}}{\log 2} \qquad b = \frac{\log 0.8}{\log 2} = -0.32193$$

First 9 units

$$y = ax^b \qquad y = 100 \text{ days} \times 9^{-0.32193} = 49.3 \text{ days}$$

It is now a short step to work out how long any unit would take to build.

Example (continued): The learning effect

These can be found be constructing the following table:

Total units (cumulative)	Cumulative average time per unit (days)	Total time for all units (days)	Incremental time for additional units (days)
8	51.2	409.60	
9	49.3	443.70	245.76

In other words, the 9th boat took 34.1 days to

This approach can be used to calculate the time taken to build any unit.

Example: The learning effect

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

The learning factor:

$$b = \frac{\text{log of learning rate}}{\log 2} \qquad b = \frac{\log 0.95}{\log 2} = -0.074$$

First 6 units

$$y = ax^b \qquad y = 500 \text{ hours} \times 6^{-0.074} = 437.9 \text{ hours}$$

First 7 units

$$y = ax^b \qquad y = 500 \text{ hours} \times 7^{-0.074} = 432.9 \text{ hours}$$

These can be used to find the incremental time as before.

Total units (cumulative)	Cumulative average time per unit (hours)	Total time for all units (hours)	Incremental time for additional units (hours)
6	437.9	2,627.4	
7	432.9	3,030.3	402.9

In other words, the 7th unit took 402.9 hours to build .

2 OTHER ASPECTS

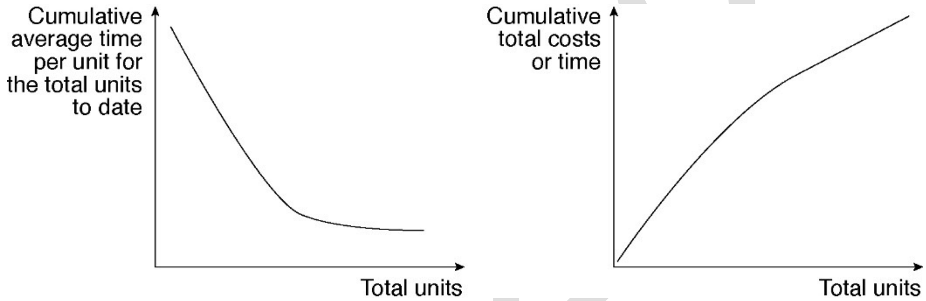
Section overview

- Graph of the learning curve
- Conditions for the learning curve to apply
- Implications of the learning curve
- Problems with the application of learning curve theory

2.1 Graph of the learning curve

The learning effect can be illustrated graphically.

Illustration: Learning effect



The cumulative average time per unit 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 total cost line curves upwards.

The slope decreases as more units are made implying that the cost per unit falls as more and more units are made.

2.2 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 and repetitive 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.

2.3 Implications of the learning curve

When a process benefits from a learning curve effect, there are implications for budgeting and pricing.

- Budgets should allow for the reduction in the average labour time per unit. Total labour requirements (the size of the work force required) will be affected.
- If prices are calculated on a ‘cost plus’ basis, prices quoted to customers should allow for future cost savings. The sales budget will be affected by expected reductions in the sales price.
- Any system of budgetary control should make allowance for the expected reduction in the production time per unit. Actual hours taken should be compared with expected hours, allowing for the learning curve effect.

2.4 Problems with the application of learning curve theory

In practice, the learning curve effect is not used extensively for budgeting or estimating costs (or calculating sales prices on a cost plus basis).

- It may be difficult to measure the learning rate with sufficient accuracy. It also may be difficult to measure the time taken for the first unit accurately.
- In a modern manufacturing environment production is highly mechanised and therefore the learning curve effect does not apply.
- Learning curve theory assumes that stable production conditions will exist, and all subsequent units will be produced to the same specifications as the original product. In practice, the product may go through several major design changes after the first unit has been produced.
- 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.

Example: The learning effect

X Ltd has developed a new product. The process used to produce the new product is repetitive, and around 60% automated.

Following reorganisation at X Ltd, the workforce is less motivated than it has been in the past and the number of resignations has increased in recent months.

Required

Evaluate the extent to which you would expect a learning curve effect to occur in respect of the new product at X Ltd.

Answer

Learning curves only apply to repetitive processes.

The new product may experience a learning effect as it is to be produced using a repetitive process.

The process is 60% automated, and learning curves can only be observed on a process that is highly labour intensive. The 40% of the process that is not automated could give rise to a learning curve, however the extent to which this will impact on the process overall is unknown. It is possible that a learning curve effect could occur, but it is unlikely to be significant.

Further, there are issues with motivation and staff turnover. Both of these factors reduce the likelihood of a learning curve effect taking place.

If staff are not motivated, they will not be keen to learn and keen to work quickly and so the learning curve will never arise.

Higher staff turnover prevents the learning curve taking place as staff are replaced too frequently for the benefits to be observed as the workers will not have sufficient time to learn the process and speed up.

Overall, the learning curve experienced in relation to the new product as X Ltd is likely to be minimal.

3 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the learning effect
- Use a tabular approach to illustrate the learning effect
- Use the learning effect formula to calculate time required for units at a given point in production as a basis for budgeting and pricing

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

Total units (cumulative)	Cumulative average time per unit (90% LF) (days)	Total time for all units (days)	Incremental time for additional units (days)	Average time for additional units (days)
1	1,600	1,600	1,600	
2	1,440	2880	1280	1280
4	1,296	5184	2304	1152.00
8	1,166.4	9331.20	4147.20	1036.80
16	1,049.76	16796.16	7464.96	933.12
32	944.78	30233.09	13436.93	839.81

Skills level
Performance management

CHAPTER 5

Quality and quality costs

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts. This has a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

A	**Cost planning and control**			
	1	**Overview of costs for planning and control**		
		C	Cost of quality	
			i	Explain quality costs.
			ii	Analyse quality costs into costs of conformance and costs of non-conformance.
			iii	Discuss the significance of quality costs for organisations.

Exam context

This chapter explains each of the above topics in turn.

By the end of this chapter, you should be able to:

- Explain the nature of quality costs
- Analyse quality costs into costs of conformance and costs of non-conformance
- Analyse costs of conformance into appraisal costs and prevention costs
- Analyse costs of non-conformance into internal and external failure costs
- Discuss the potential significance of quality costs, including reputation costs, for organisations
- Explain approaches to the management of quality costs including the Total Quality Management approach.

1 QUALITY MANAGEMENT AND QUALITY COSTS

Section overview

- ❑ The importance of quality
- ❑ Quality-related costs
- ❑ Quality-related costs: costs of conformance and costs of non-conformance

1.1 The importance of quality

Success in business depends on satisfying the needs of customers and meeting the requirements of customers. An essential part of meeting customers' needs is to provide the quality that customers require. Quality is therefore an important aspect of product design and marketing.

Quality is also important in the control of production processes. Poor quality in production will result in losses due to rejected items and wastage rates, sales returns by customers, repairing products sold to customers (under warranty agreements) and the damaging effect on sales of a loss of reputation.

An entity should seek to minimise quality-related costs. In order to do this, quality-related costs should be measured, analysed and controlled. However in many organisations the management accounting system does not capture, analyse and report on quality cost data. This chapter indicates how quality-related costs could be measured.

1.2 Quality-related costs

Quality-related costs can be defined as: 'the expenditure incurred in defect prevention and appraisal activities and the losses due to internal and external failure of a product or service, through failure to meet the agreed specification'.

An organisation must incur costs to deal with quality.

- ❑ It incurs costs to maintain the required quality standards, and to prevent poor quality, or detect poor quality items when they occur. These are costs of conformance.
- ❑ It incurs costs in correcting the problem when poor quality does occur. These are costs of non-conformance.

The **cost of quality** can be defined as: 'The cost of ensuring and assuring quality, as well as the loss incurred when quality is not achieved'. The aim should be to minimise the total of quality-related costs.

1.3 Quality-related costs: costs of conformance and costs of non-conformance

Dr Armand Feigenbaum is considered a 'quality guru': he developed the concept of **total quality control (TQC)** in the 1950s. The explanation of quality costs that follows in the rest of this chapter is based on Feigenbaum's analysis and categorisation of quality costs.

The following formula sets out the total costs of quality, as defined by Dr Armand Feigenbaum in the 1950s. This is now a well-established method of analysing quality costs.

Formula: Quality costs

Total costs of quality	**=**	**Costs of conformance (costs of control)**	**+**	**Costs of non-conformance (costs of failure)**
Costs of conformance	**=**	**Prevention costs**	**+**	**Appraisal costs**
and				
Costs of non-conformance	**=**	**Internal failure costs**	**+**	**External failure costs**

2 COSTS OF CONFORMANCE

Section overview

- ❑ Appraisal costs
- ❑ Prevention costs

2.1 Appraisal costs

No matter how much money is spent on preventing quality failures, some failures will almost certainly occur. Prevention measures cannot provide a 100% guarantee of quality. Consequently some inspection checks are needed to test whether quality standards are being maintained, and if possible to identify defective items that do occur.

Appraisal costs are the costs that are incurred to detect defective items before they are delivered to customers and to deal with faults or defects that are discovered. These costs are normally associated with inspection, and are the costs incurred as part of the inspection process, in order to ensure that incoming materials and other supplies – and outgoing finished products – are of the 'right quality'. They also include the costs of quality tests and quality audits.

Appraisal costs are incurred either after items have been supplied or produced, or during the process of production.

Quality inspections may have the objective of identifying all defects, and rejecting them as unacceptable. Defective materials or parts from a supplier are returned to the supplier. Defective items that occur during production are either scrapped or re-worked to eliminate the defect.

However, when an organisation is buying a large number of items and in large quantities, inspecting 100% of items purchased would be a time-consuming and expensive process, unless all items can be checked automatically within a fully-automated production process.

For this reason, it is usual for quality inspections to be carried out on a sample of items, not 100% of items. The results from the sample testing are used to assess whether quality standards are on the whole within acceptable limits.

Here are some examples of appraisal costs.

- ❑ inspecting purchased items on delivery, to check whether they meet the required specifications;
- ❑ in a manufacturing process, checking items as soon as possible during the process, or checking finished items for defects;
- ❑ carrying out a **quality audit** from time to time, to assess whether quality standards are up to the level required and the quality control system is working as intended.

The costs incurred may consist of:

- ❑ the costs of labour time spent on inspecting;
- ❑ the costs of inspection equipment.

2.2 Prevention costs

Prevention costs are the costs of action to prevent defects (or reduce the number of defects). They are costs incurred to prevent a quality problem from arising.

Quality problems can arise for a variety of reasons:

- The initial design of the product and the method of making it may be poor, so that there will be a large number of sub-standard items produced.
- The raw materials used to make the product may be poor in quality, and better-quality raw materials may reduce the wastage rate in production.
- The work force may be badly trained, and so may make a large number of errors in production.
- Faulty output may occur when the production machinery is not in good working order, which may be caused by insufficient maintenance and repair work on the machines.

Prevention costs are the costs incurred in preventing these problems from happening.

Investing in the prevention of quality failures will result in fewer failures and so less need for inspections, and a reduction in appraisal costs and quality failure costs. A solution to the problem of quality failures is to prevent them from happening. Spending on prevention measures can be justified by much bigger savings in appraisal costs and costs of quality failures.

Prevention costs are costs incurred in order to reduce appraisal costs and the costs of quality failures, by preventing or reducing defects and failures produced by the process, and to reduce the need to spend money on inspections and testing for quality failures.

Examples of measures that might be taken to reduce quality failures are:

- Quality planning: establishing clear specifications for the quality standards required in a product, service or process. By paying closer attention to getting specifications 'right', particularly in product design, costs of appraisal and quality failure costs can be reduced;
- Investing in systems and equipment to achieve the required quality standard;
- Training staff to recognise the importance of quality and 'getting things right first time';
- Choosing only those suppliers that can be expected to deliver supplies to the required quality standard.

3 COSTS OF NON-CONFORMANCE

Section overview

- Internal failure costs
- External failure costs

3.1 Internal failure costs

Internal failures are quality failures that:

- occur when products are defective because they do not conform to requirements or specifications; but
- are discovered before the product is delivered to the customer.

They are failures that would otherwise have led to the external customer being dissatisfied, if they had been delivered. Internal failures are caused either by defects in products (failure of the product to meet specifications) and inefficiencies in the production process.

Internal failures may be identified when defective items are found in the inspection or testing process, or when there is a breakdown in the production process. Items that are inspected and found to be faulty will be either:

- rejected and thrown out, or
- re-worked so that they meet the required quality standard.

Internal failure costs are costs incurred when defective production occurs. They include:

- the variable cost of items that are scrapped when found to be sub-standard in quality
- the incremental cost of re-working items to bring them to the required quality standard
- the cost of production time lost due to failure and defects. If a factory is working at full capacity and is unable to keep up with sales demand, this cost would include the contribution lost as a consequence of producing less finished output and so selling less.

3.2 External failure costs

External failure costs are costs incurred when the quality problem arises after the goods have been delivered to the customer. They include the costs of:

- dealing with customers' complaints
- carrying out repair work under a guarantee or warranty
- transport costs incurred when recovering faulty items from customers
- transport costs incurred in delivering repaired items or replacement items to customers
- recalling all items from customers in order to correct a design fault
- legal costs, when a customer takes the organisation to court

- the cost of lost reputation: when an organisation gets a reputation for poor quality, customers will stop buying from it.

Reputational costs

Corporate reputation can be defined as the overall estimation in which a company is held by its customers. Reputations are built up over time, and it is increasingly recognised that reputation is an important intangible asset. A strong positive reputation can differentiate a company from its competitors, and help to attract and retain customers. There is evidence that a good reputation enhances profitability and contributes to the longer-term success of an organisation, by maintaining customer and supplier loyalty, supporting the recruitment and retention of high-quality personnel, and improving competitiveness.

Conversely, a negative reputation – or reputational damage – can erode customer support for the company and its products.

'Reputational risk' is the risk of damage to reputation, and the resulting consequences. The cost of a poor reputation (a failure to satisfy customers) is an external failure cost.

4 THE SIGNIFICANCE OF QUALITY COSTS

Section overview

- Managing quality costs
- Complications in the interpretation of quality costs
- Managing quality-related costs: Total Quality Management

4.1 Managing quality-related costs

The traditional approach to managing quality costs recognises that there is a relationship between costs of conformance and costs of non-conformance.

The 'traditional view' of managing quality costs is that the total of all quality costs should be minimised.

- An organisation should spend more money on prevention and detection costs, if this reduces internal and external failure costs by a larger amount.
- On the other hand, there is no reason to spend more on preventing poor quality if the benefits do not justify the extra cost.

The first step in reducing the costs of quality is to calculate the total cost the organisation is incurring for quality.

Example: Calculating the costs of quality

X Limited has experienced quality issues with a new product.

Production information is as follows:

PRODUCTION DATA	
Units manufactured and sold	20,000 units
Units requiring rework	3,000 units
Units requiring warranty repair service	4,000 units

The following information is available about the company's efforts in respect of quality:

Engineering hours	5,000 hours
Inspection hours (manufacturing)	32,000 hours
Engineering cost per hour	₦105
Inspection cost per hour	₦55
Rework cost per unit reworked	₦5,280
Customer support per warranty repair (per unit)	₦265
Warranty repairs per repaired unit	₦2,000
Staff training costs	₦195,000
Additional product testing costs	₦80,000

Example(continued): Calculating the costs of quality

A quality cost analysis can be prepared as follows:

	₦,000	₦,000
Prevention costs		
Training	195	
Engineering (5,000 × 105)	525	
Appraisal costs		720
Inspection costs (32,000 × 55)	1,760	
Product testing	80	
		1,840
Costs of conformance		2,560
Internal failure costs		
Rework (3,000 × 5,280)	15,840	
External failure costs		
Repairs (4,000 × (265 + 5050))	21,260	
Costs of conformance		37,100
Total cost of quality		39,660

In this case, the company's costs of conformance are much smaller than its costs of non-conformance. An investment in the costs of conformance might result in savings in the costs of non-conformance so that overall the total cost of quality would fall.

Example(continued): Calculating the costs of quality

Following on from the previous example, the company is considering investing in costs of conformance as follows:

Training costs are to be doubled

Engineering hours are to be trebled

Inspection hours are to be increased five fold

Product testing cost to be trebled

Analysis has led the company to believe that the above measures would result in the following:

Units requiring rework	2,000 units
Units requiring warranty repair service	2,000 units

Example(continued): Calculating the costs of quality

A new quality cost analysis can be prepared as follows:

	₦,000	₦,000
Prevention costs		
Training (195,000 × 2)	390	
Engineering (5,000 × 3 × 105)	1,575	
Appraisal costs		1,965
Inspection costs (32,000 × 5 × 55)	8,800	
Product testing (80 × 3)	240	
		9,040
Costs of conformance		11,005
Internal failure costs		
Rework (2,000 × 5,280)	10,560	
External failure costs		
Repairs (2,000 × (265 +5050))	10,630	
Costs of conformance		21,190
Total cost of quality		32,195

Therefore the initiative would reduce the total quality costs.

	₦,000
Before the initiative	39,660s
After the initiative	32,195
Quality cost reduction	7,465

4.2 Complications in the interpretation of quality costs

Using percentages

Quality costs are often expressed as percentages of sales value. However, they can also be expressed as a percentage of production costs. The distinction is important to understand when analysing data.

Example: Calculating the costs of quality

The following information is available for a company.

	₦,000
Revenue	1,000
Production costs	(800)
Gross profit	200

a) If quality costs are 10% of revenue

The production costs can be analysed as follows:

Quality costs (10% of 1,000)	100
Other production costs (balancing figure)	700
Total production costs	800

a) If quality costs are 10% of production costs

The production costs can be analysed as follows:

Quality costs (10% of 800)	80
Other production costs (balancing figure)	720
Total production costs	800

A question might require you to calculate the number of units that need to be produced in order to achieve a level of good output subject to a given failure rate. In this case, the number produced can be found by grossing up the number required to be sold to take account of the production failures.

Example

A company's production process losses 20% of units input.

The number of units that must be input in order to achieve output of 100 good units is:

100 units × 100/80 = 125 units (or 100 units ÷ 0.8 = 125 units)

Proof	Units
Units input to production	125
Losses in production (20% of 125)	(25)
Good output	100

Practice question **1**

A company is considering investing in a new quality initiative.

It has made the following estimates of losses incurred in order to achieve an output of 1,000 good units (i.e. free from defects).with and without this initiative.

	Before quality initiative	After quality initiative
Losses in production	5%	1%
Rejections on final inspection	10%	6%

Both units of good output and units lost and rejected costs ₦700 to produce.

What is the maximum amount that the company should pay for the quality improvement per batch of 1,000 units?

Timing of benefits

As stated above, the 'traditional view' of managing quality costs is that the total of all quality costs should be minimised. When analysing the success or otherwise of a change in policy to reduce total quality costs it is important to understand that benefits resulting from increase spend on costs of conformance may not be experienced instantly. There may be a delay as the result of the changes work through the system.

Example: Timing of changes in quality costs

A company has collected the following information:

	Period 1	Period 2	Period 3	Period 4
	₦,000	₦,000	₦,000	₦,000
Appraisal costs	50	100	100	100
Prevention costs	60	65	100	120
	110	165	200	220
Internal failure costs	250	300	220	180
External failure costs	300	240	180	150
	550	540	400	330
Total quality costs	660	705	600	550

Analysis:

Period 1: 83.3% of the quality costs were the result of internal and external failure.

Period 2: The company doubled spending on appraisal. This led to the company identifying higher numbers of low quality items. This increased the internal failure costs but resulted in a fall in the external failure costs (as fewer flawed items were sent to customers).

Period 3: The information gathered in period 2 as a result of the investment in appraisal costs allowed the company to identify quality improvements leading to an increase in the prevention budget. This led to a fall in internal failure costs and a continued fall in external failure costs.

Period 4: The trends established in period 3 continued. Increased prevention costs leads to further reductions in internal failure costs and external failure costs.

The company has endured an increase in total quality costs from period 1 to period 2 but has benefited from the changes in periods 3 and 4.

4.2 Total Quality Management

Customers' needs can be satisfied to some extent by cutting costs and selling at lower prices. However, strategies to achieve customer satisfaction must also focus on three other critical success factors:

- quality;
- time; and
- innovation.

One approach to achieving improvements in these critical success factors is a Total Quality Management programme.

Total Quality Management (TQM) is a philosophy of quality management with its origins in Japan in the 1950s.

Definition: Total quality management

An integrated and comprehensive system of planning and controlling all business functions so that products or services are produced which meet or exceed customer expectations.

CIMA Official Terminology

TQM is a philosophy of business behaviour, embracing principles such as employee involvement, continuous improvement at all levels and customer focus, as well as being a collection of related techniques aimed at improving quality such as full documentation of activities, clear goal-setting and performance measurement from the customer perspective.

The 'traditional view' outlined above is rejected by supporters of TQM. The TQM view is that it is impossible to identify and measure all quality costs. In particular, it is impossible to measure the costs of lost reputation, which will lead to a decline in sales over time. The aim should therefore always be to work towards zero defects. To achieve zero defects, it will be necessary to spend more money on prevention costs.

The TQM approach to quality costs is to 'get things right the first time'.

5 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the nature of quality costs
- Analyse quality costs into costs of conformance and costs of non-conformance
- Analyse costs of conformance into appraisal costs and prevention costs
- Analyse costs of non-conformance into internal and external failure costs
- Discuss the potential significance of quality costs, including reputation costs, for organisations.
- Explain approaches to the management of quality costs including the Total Quality Management approach

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

The number of units of input needed to produce 1,000 units of good output before and after the quality initiative can be calculated as follows:

	Units	
	Before the initiative	After the initiative
Desired good output	1,000	1,000
Losses at final inspection (balancing figure)	111	64
Units that reach final inspection		
1,000 × 100/90 (or 1,000/0.9)	1,111	
1,000 × 100/94 (or 1,000/0.94)		1,064
Losses during production (balancing figure)	58	11
Units that are input at the start		
1,111 × 100/95 (or 1,000/0.95)	1,169	
1,064 × 100/99 (or 1,000/0.99)		1,075

Proof

Input at the start	1,169	1,075
Losses during production (5%/1%)	(58)	(11)
Units that reach final inspection	1,111	1,064
Losses at final inspection (10%/6%)	(111)	(64)
Good output	1000	1,000

The maximum price that should be paid to achieve the quality improvements (per batch of 1,000 units) is calculated as follows:

Units of input to achieve output of 1,000 units:	
Before the initiative	1,169
After the initiative	(1,075)
Units saved due to the initiative	94
Cost per unit (₦)	×700
Saving per 1,000 units of good output (₦)	65,800

Skills level
Performance management

CHAPTER 6

Budgetary control systems

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

B	**Planning and control**		
	1	**Budgetary system, planning and control**	
		A	Discuss and apply forecasting techniques to planning and control.
		B	Discuss budgetary system in an organization as an aid to performance management.
		C	Evaluate the information used in budgetary system.
		D	Discuss the behavioural aspects of budgeting.
		E	Discuss the usefulness and problems associated with different types of budget.
		F	Explain ***beyond budgeting*** models.

Exam context

This chapter explains the purpose of budgetary control systems and continues by explaining different types of approaches to budgeting. Standard costing is of particular importance as it is the foundation of variance analysis (covered in the next two chapters). The concluding section of the chapter covers the behavioural aspects of budgeting.

By the end of this chapter, you should be able to:

- Explain the purposes of budgeting and the budgeting process
- Describe the main features of, and explain the differences between bottom-up and top-down budgeting
- Explain incremental and zero-based budgeting
- Explain activity based budgeting (ABB)
- Recognise and explain the importance of the behavioural aspects of budgeting
- Discuss beyond budgeting as a concept
- Explain and apply forecasting techniques

1 THE BUDGETING PROCESS

Section overview

- Introduction to budgeting
- Preparing the budget
- Principal budget factor
- Stages in the budgeting process

1.1 Introduction to budgeting

Planning framework

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.
- Medium-term or tactical planning focuses on the next year or two.
- Short-term or operational planning focuses on day-to-day and week-to-week plans.

Budgets are medium-term plans for the business, expressed in financial terms. A typical budget is prepared annually, and the overall budget is divided into control periods for the purpose of control reporting.

The nature of budgets

Definition: Budget

A budget is a financial and/or quantitative statement prepared and approved prior to a defined period of time for the purpose of attaining a set of given objectives

A budget is a formal plan, expressed mainly in financial terms and covering all the activities of the entity. It is for a specific period of time, typically one year. When budgets are prepared annually, they are for the next financial year.

The total budget period (one year) may be sub-divided into shorter control periods of one month or one quarter (three months).

Purposes of budgeting

Budgets have several purposes.

- To convert long-term plans (strategic plans) into more detailed shorter-term (annual) plans.
- To ensure that planning is linked to the long-term objectives and strategies of the organisation.
- To co-ordinate the actions of all the different parts of the organisation, so that they all work towards the same goals. (This is known as 'goal congruence'). One of the benefits of budgeting is that is covers all activities, so the plan should try to ensure that all the different activities are properly co-ordinated and working towards the same objective.

- To communicate the company's plans to the individuals (managers and other employees) who have to put the plans into action.
- To motivate managers and employees, by setting targets for achievement, and possibly motivating them with the incentive of bonuses or other rewards if the targets are met.
- To provide guidelines for authorising expenditure. Expenditure might not be permitted unless it has been planned in the budget or unless it is within the budgeted expenditure limits for the department.
- To identify areas of responsibility for implementing the plans. For each part of the budget, an individual manager should be made responsible for achieving the budget targets for performance.
- To provide a benchmark against which actual performance can be measured.
- To control costs. Costs can be controlled by comparing budgets with actual results and investigating any differences (or variances) between the two. This is known as **budgetary control**.

1.2 Preparing the budget

Preparing the annual budget is a major activity for many entities. In many medium-sized and large companies, there is a well-defined process for budget preparation, because a large number of individuals have to co-ordinate their efforts to prepare the budget plans. The budgeting process may take several months, from beginning to eventual approval by the board of directors.

The budgeting process might be supervised and controlled by a special committee (the **budget committee**). This consists of senior managers from all the main areas of the business. The committee co-ordinates the various functional budgets submitted to it for review, and gives 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 budgeting process, the functional budgets are usually prepared by the managers with responsibility for the particular aspect of operations covered by that functional budget.

Budget manual

There should be a budget manual or budget handbook to guide everyone involved in the budgeting process,. This should set out:

- the key objectives of the budget;
- budget planning procedures and budget timetables;
- the budget details that must be included in the functional budgets;
- responsibilities for preparing the functional budgets; and
- details of the budget approval process. The budget must be approved by the budget committee and then by the board of directors.

The master budget

The 'master budget' is the final approved budget. It is usually presented in the form of financial statements - a budgeted statement of profit or loss and a budgeted statement of financial position for the end of the financial year.

However the master budget is the result of a large number of detailed plans, many of them prepared at a departmental or functional level. To prepare the master budget, it is therefore necessary to prepare functional budgets first.

Functional budgets

A functional budget is a budget for a particular aspect of the entity's operations. The functional budgets that are prepared vary with the type of business and industry. In a manufacturing company, functional budgets should include:

- a sales budget;
- a production budget;
- a budget for production resources and resource costs (such as a materials cost budget and a labour cost budget);
- a materials purchasing budget; and
- an expenditure budgets for every overhead cost centre and general overhead costs.

1.3 Principal budget factor

The budgeting process begins with the preparation of functional budgets, which must be co-ordinated and consistent with each other. To make sure that functional budgets are co-ordinated and consistent, the first functional budget that should be prepared is the budget for the principal budget factor.

The principal budget factor (also called the key budget factor) is the factor in the budget that will set a limit to the volume and scale of operations.

Sales demand (sales volume) as the principal budget factor

Normally, the principal budget factor is the expected sales demand. When this happens, the expected sales demand should set a limit on the volume of production (or volume of services). A company might have the capacity to increase its production and output, but producing larger quantities has no purpose unless the extra quantities can be sold.

A company will therefore prepare a budget on the basis of the sales volumes that it hopes or expects to achieve. When sales demand is the principal budget factor, the sales budget is the first functional budget that should be prepared.

A principal budget factor other than sales volume

Sometimes, there is a different limitation on budgeted activity. There might be a shortage of a key resource, such as machine time or the availability of skilled labour. When there is a shortage of a resource that will set a limit on budgeted production volume or budgeted activity, the first functional budget to prepare should be the budget for that resource.

In government, the principal budget factor for each government department is often an expenditure limit for the department. The department must then prepare a budget for the year that keeps the activities and spending plans of the department within the total expenditure limit for the department as a whole.

1.4 Stages in the budgeting process

The budgeting process for a manufacturing company is probably more complex than for many other types of organisation, and manufacturing company budgets are more likely to be the subject of an examination question than budgets for companies in other industries. This chapter therefore describes the budgeting process for a manufacturing company.

The stages in setting the budget might be as follows.

- **Stage 1**: The provision and communication of budget guidelines to relevant managers
- **Stage 2**: Identify the principal budget factor (or key budget factor). The principal budget factor is often sales volume.
- **Stage 3**: Prepare the functional budget or plan for the principal budget factor. Usually, this means that the first functional budget to prepare is the sales budget.
- All the other functional budgets should be prepared within the limitation of the principal budget factor. For example, even if the company has the capacity to produce more output, it should not produce more than it can sell (unless it formally decides to increase the size of the finished goods inventory, in which case the production volume will be higher than the sales volume).
- **Stage 4**: 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 (= plans to increase or reduce the size of its inventories), a production budget, labour usage budgets and materials usage and purchasing budgets. Expenditure budgets should also be prepared for overhead costs (production overheads, administration overheads and sales and distribution overheads). Overhead costs budgets are usually prepared for each cost centre individually.
- **Stage 5**: 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.
- **Stage 6**: 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 statement of profit or loss 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 7**: The master budget and the supporting functional budgets should be submitted to the board of directors for approval. The board approves and authorises the budget.
- **Stage 8**: The detailed budgets are communicated to the managers responsible for their implementation.

- **Stage 9**: Control process. After the budget has been approved, actual performance should be monitored by comparing it with the budget. Actual results for the period should be recorded and reported to management. These results should be compared with the budget, and significant differences should be investigated. The reasons for the differences ('variances') should be established, 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 will be held responsible and accountable.

The planning process (budgeting) should therefore lead on to a management monitoring and control process (budgetary control).

The next section describes the approach that can normally be used to prepare functional budgets for a manufacturing organisation. In practice, budgets are usually prepared with a computer model, such as a **spreadsheet**. However, you need to understand the logic of budget preparation.

Practice question **1**

X Limited makes and sells two products, Product X and Product Y.

Its sales budget for next year is to sell 2,500 units of Product X at a sales price of ₦410 per unit and 3,200 units of Product Y at a sales price of ₦400 per unit.

The following cost information is expected to apply in the next year:

	Product X		Product Y	
Direct materials	Usage (kgs)	Cost per unit of X (₦)	Usage (kgs)	Cost per unit of Y (₦)
Material A (₦30 per kg)	1.00	30	1.00	30
Material B (₦80 per kg)	0.75	60	0.50	40
Material C (₦30 per kg)	2.00	60	3.00	90
		150		160
Direct labour	Usage (hrs)		Usage (hrs)	
Grade I (₦100 per hr.)	1.00	100	0.80	80
Grade II (₦80 per hr.)	1.50	120	1.00	80
		220		160
Unit cost		370		320

The following opening and closing inventories are budgeted:

		Opening		Closing	
Finished goods:	Cost (₦)	Units	Total (₦)	Units	Total (₦)
X	370	300	111,000	200	74,000
Y	320	150	48,000	100	32,000
			159,000		106,000
Materials:	Cost	kgs		kgs	
A	30	400	12,000	380	11,400
B	80	450	36,000	400	32,000
C	30	150	4,500	120	3,600
			52,500		47,000
Total inventory			211,500		153,000

Required

a) Prepare functional budgets for sales, production units, material usage, material purchases and labour usage.

b) Prepare a budgeted profit or loss account for the period.

2 BUDGETARY SYSTEMS

Section overview

- Top-down budgeting and bottom-up budgeting
- Periodic budgets and rolling budgets (continuous budgets)
- Incremental budgeting and zero-based budgeting (ZBB)
- Activity based budgeting (ABB)
- Feed-forward control
- Difficulties in changing a budgetary system

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.

2.1 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.

2.2 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.

Example:

A company might prepare rolling annual budgets every three months. It will prepare four annual budgets each year. If its year-end is 31st December, its preparation of rolling budgets would be as follows:

Date of budget preparation	Period covered by the budget
December Year 1	1st January – 31st December Year 2
March Year 2	1st April Year 2 – 31st March Year 3
June Year 2	1st July Year 2 – 30th June Year 3
September Year 2	1st October Year 2 – 30th September Year 3
December Year 2	1st January – 31st December Year 3
and so on	

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 **advantages** of rolling budgets are as follows:

- ❑ Budgets are continually reviewed and revised in response to changes in business conditions. The entity is not committed to a fixed annual budget that is no longer relevant.
- ❑ Control can be exercised through comparisons between current forecasts and strategic targets. This is a form of **feedforward control**. When the business environment is continually changing, this may be a more effective method of budgetary control than comparing actual results with the fixed budget or standard costs.

The main **disadvantages** of rolling budgets are as follows:

- ❑ They can be **time-consuming**, and divert management attention from the task of managing actual operations.
- ❑ Whenever a new rolling budget is prepared, the new plans must be communicated to all managers affected by the changes. There is a risk that some managers will not be informed about changes to plans and targets.

2.3 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 (sometimes called '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.

> **Definition: Zero-based budgeting**
>
> A budget prepared from the "basement" or the "ground up" as if the budget were being prepared for the first time.

ZBB 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 and 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.

2.4 Activity based budgeting (ABB)

Background

Activity-based budgeting is a planning system under which costs are associated with activities, and budgeted expenditures are then compiled based on the expected activity level.

Activity based budgeting (ABB) is an extension of activity based costing (ABC) which is an alternative approach to traditional absorption costing.

Traditional absorption accounting identifies overheads and absorbs them into units of production or services using a volume based approach. For example, overheads might be absorbed as an amount per direct labour hour or an amount per unit of material used when making a product.

Traditional absorption costing has many weaknesses, especially in a ‘modern’ manufacturing environment where production overhead costs are often high relative to direct production costs. Therefore, a system of adding overhead costs to product costs by using time spent in production (direct labour hours or machine hours) is difficult to justify.

Activity based costing assumes that overhead costs are caused by activities, and the costs of activities are driven by factors other than production volume. For each activity, there should be a cost driver. A cost driver is the 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.

When an entity uses activity based costing, it should be able to prepare activity based budgets. These are budgets prepared using activity based costing methods, and budgets for overheads are therefore prepared as activity costs.

Definition: Activity-based budgeting

Activity-based budgeting (ABB) is a method of budgeting based on an activity framework, using cost driver data in the budget setting and variance feedback processes.

CIMA Official Terminology

The preparation of an activity based budget requires the following steps:

Step	Description
1	Identify activities and their cost drivers
2	Forecast the number of units of cost driver for the required activity level
3	Calculate the cost driver rate (cost per unit of activity). for the coming period

Example: Activity based budgeting

A company expects to process 50,000 sales orders in the coming budget period.(NB this is not to sell 50,000 units but to make 50,000 sales with each sales comprising a different number of units).

The forecast cost of processing a single sales order is ₦10 regardless of the number of units to be sold in that order.

The budgeted cost of selling overhead is calculated as follows:

Step 1	
Activity	Sales
Cost driver	Making a sale
Step 2: Number of units of cost driver	50,000
Step 3: Calculate the cost driver rate	₦10
Budgeted sales overhead	₦500,000

The above example provided a cost driver rate (₦10 per sale). It is important to realise that the cost of an activity would have to be calculated and that might be quite difficult to do.

The company would have to analyses its costs and identify those which related to processing sales orders. This might be a little tricky. For example, part of the cost of processing the order might involve the accounts department raising an invoice. However, the person who raises the invoice will have other duties so not all of the salary costs would necessarily relate to sales.

Advantages of activity-based budgeting

- It gives managers a much better understanding of the link between costs and output of the business.
- It focuses attention on expensive activities and management might be able to reduce the cost of these to increase profit.
- It might allow management to increase resource to eliminate bottlenecks associated with an activity and allow business functions to run more smoothly.
- 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.
- Activities drive costs. By identifying cost drivers, it might be assumed that Resources are clearly matched to its service provision

Disadvantages of activity-based budgeting

- It is complex in nature and very difficult to set up.
  - it requires a great deal of preliminary analysis and research to trace costs back to activities; and
  - accounting information systems would have to be modified to track costs that relate to activities.
- As a result of the work necessary before it can be used it is expensive to set up. (it is most useful to companies that have already introduced activity based costing because they already have a strong insight into what is needed to introduce activity-based budgeting).
- It is complex to operate.
- It is not practical for services where a flexible approach is required and/or where resources need to be moved between activities in response to demand.

2.5 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 to 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.

2.6 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 DEALING WITH UNCERTAINTY IN BUDGETING

Section overview

- Limitations of a 'fixed' budget
- The nature of uncertainty in budgeting
- Flexible budgets
- Probabilities and expected values
- Spreadsheets and 'what if' analysis

3.1 Limitations of a 'fixed' budget

Weaknesses in the traditional budgeting process have been recognised, and alternative budgeting models have been developed to improve the quality of budgets and budgetary control.

A major weakness with an annual budget is that it is a fixed annual plan. Once it has been prepared, it usually remains the 'official' plan until it is replaced by the next annual budget 12 months later.

'Fixed' annual budgets are unsatisfactory for two important reasons.

- ❑ When a budget is prepared, there is a great deal of uncertainty about what will happen, and the budget will be based on estimates. Even when estimates are reasonable, there is no certainty that they will turn out to be 'correct'.
- ❑ Unexpected events will happen during the year, and conditions in the business environment will change. The changes might be significant, and the 'fixed' budget will cease to be realistic and achievable. It might therefore be appropriate to re-consider and revise the budget.

3.2 The nature of uncertainty in budgeting

There is uncertainty in budgeting because estimates and forecasts may be unreliable. Information is almost never 100% reliable (or 'perfect'), and some uncertainty in budgeting is therefore inevitable.

Risk arises in business because actual events may turn out better or worse than expected. For example, actual sales volume may be higher or lower than forecast. The amount of risk in business operations varies with the nature of the operations. Some operations are more predictable than others. The existence of risk means that forecasts and estimates in the budget, which are based on expected results, may not be accurate.

Both risk and uncertainty mean that estimates and forecasts in a budget are unlikely to be correct.

Management must be aware of risk and uncertainty when preparing budgets and when monitoring performance.

- ❑ When preparing budgets, it may be appropriate to look at several different forecasts and estimates, to assess the possible variations that might occur. In other words, managers should think about how much better or how much worse actual results may be, compared with the budget.

- When monitoring actual performance, managers should recognise that adverse or favourable variances might be caused by weaknesses in the original forecasts, rather than by good or bad performance.

Several approaches may be used for analysing risk and uncertainty in budgets. These include:

- flexible budgets;
- using probabilities and expected values;
- use feed-forward control;
- using spreadsheet models and 'what if' analysis (sensitivity analysis); and
- stress testing.

3.3 Flexible budgets

Flexible budgets may be prepared during the budget-setting process. A flexible budget is a budget based on an assumption of a different volume of output and sales than the volume in the master budget or 'fixed budget'.

An organisation might prepare several flexible budgets in addition to the main budget (the master budget or fixed budget). If the actual level of activity differs significantly from the expected level, the fixed budget can be substituted by a suitable flexible budget.

For example, a company might prepare its master budget on the basis of estimated sales of ₦100 million. Flexible budgets might be prepared on the basis that sales will be higher or lower – say ₦80 million, ₦90 million, ₦110 million and ₦120 million. Each flexible budget will be prepared on the basis of assumptions about fixed and variable costs, such as increases or decreases in fixed costs if sales rise above or fall below a certain amount, or changes in variable unit costs above a certain volume of sales.

During the financial year covered by the budget, it may become apparent that actual sales and production volume will be higher or lower than the fixed budget forecast. In such an event, actual performance can be compared with a suitable flexible budget.

Flexible budgets can be useful, because they allow for the possibility that actual activity levels may be higher or lower than forecast in the master budget. The main disadvantage of flexible budgets could be the time and effort needed to prepare them. The cost of preparing them could exceed the benefits of having the information that they provide.

Flexible vs flexed

Note that a flexible budget is not the same as a flexed budget.

A flexible budget is prepared before the start of a budget period. It is described as being ex-ante.

A flexed budget is prepared after the end of a budget period. It is described as being ex-post. A flexed budget is one that is redrafted to actual levels of activity for control purposes. The concept of a flexed budget is fundamental to variance analysis which is covered in a later chapter.

3.4 Probabilities and expected values

Estimates and forecasts in budgeting may be prepared using probabilities and expected values. An expected value is a weighted average value calculated with probabilities.

Example: Expected value

A company is preparing a sales budget. The budget planners believe that the volume of sales next year will depend on the state of the economy.

State of the economy	Sales for the year
	₦ million
No growth	40
Low growth	50
Higher growth	70

It has been estimated that there is a 60% probability of no growth, a 30% probability of low growth and a 10% probability of higher growth.

The expected value (EV) of sales next year could be calculated as follows:

State of the economy	Sales for the year	Probability	EV of sales
	₦ million		₦ million
No growth	40	0.6	24
Low growth	50	0.3	15
Higher growth	70	0.1	7
EV of sales			46

The company might decide to prepare a sales budget on the assumption that annual sales will be ₦46 million.

The problems with using probabilities and expected values

There are two problems that might exist with the use of probabilities and expected values.

- The estimates of probability might be subjective, and based on the judgement or opinion of a forecaster. Subjective probabilities might be no better than educated guesses. Probabilities should have a rational basis.
- An expected value is most useful when it is a weighted average value for an outcome that will happen many times in the planning period. If the forecast event happens many times in the planning period, weighted average values are suitable for forecasting. However, if an outcome will only happen once, it is doubtful whether an expected value has much practical value for planning purposes.

This point can be illustrated with the previous example of the EV of annual sales. The forecast is that sales will be ₦40 million (0.60 probability), ₦50 million (0.30 probability) or ₦70 million (0.10 probability). The EV of sales is ₦46 million.

- The total annual sales for the year is an outcome that occurs only once. It is doubtful whether it would be appropriate to use ₦46 million as the budgeted sales for the year. A sales total of ₦46 million is not expected to happen.

- It might be more appropriate to prepare a fixed budget on the basis that sales will be ₦40 million (the most likely outcome) and prepare flexible budgets for sales of ₦50 million and ₦70 million.

When the forecast outcome happens many times in the planning period, an EV might be appropriate.

Example: Expected value

A company is preparing a sales budget. The budget planners believe that the volume of sales next year will depend on the state of the economy.

State of the economy	Sales for the year
	₦ million
No growth	40
Low growth	50
Higher growth	70

It has been estimated that there is a 60% probability of no growth, a 30% probability of low growth and a 10% probability of higher growth.

The expected value (EV) of sales next year could be calculated as follows:

Sales for the year	Probability	EV of sales
₦		₦ million
7,000	0.5	3,500
9,000	0.3	2,700
12,000	0.2	2,400
		8,600

If the probability estimates are fairly reliable, this estimate of annual sales should be acceptable as the annual sales budget.

3.5 Spreadsheets and 'what if' analysis

Preparing budgets is largely a 'number crunching' exercise, involving large amounts of calculations. This aspect of budgeting was made much easier, simpler and quicker with IT and the development of computer-based models for budgeting. Spreadsheet models, or similar planning models, are now widely used to prepare budgets.

A feature of computer-based budget models is that once the model has been constructed, it becomes a relatively simple process to prepare a budget. Values are input for the key variables, and the model produces a complete budget.

Amendments to a budget can be made quickly. A new budget can be produced simply by changing the value of one or more input variables in the budget model.

This ability to prepare new budgets quickly by changing a small number of values in the model also creates opportunities for **sensitivity analysis** and **stress testing**. The budget planner can test how the budget will be affected if forecasts and estimates are changed, by asking 'what if' questions. For example:

- What if sales volume is 5% below the budget forecast?
- What if the sales mix of products is different?
- What if the introduction of the new production system or the new IT system is delayed by six months?
- What if interest rates go up by 2% more than expected?
- What if the fixed costs are 5% higher and variable costs per unit are 3% higher?

Sensitivity analysis and stress testing are similar.

- Sensitivity analysis considers variations to estimates and input values in the budget model that have a reasonable likelihood of happening. For example, variable unit costs might be increased by 5% or sales forecasts reduced by 5%.
- Stress testing considers the effect of much greater changes to the forecasts and estimates. For example, what might happen if sales are 20% less than expected? Or what might happen if the price of a key raw material increases by 50%?

The answers to 'what if' questions can help budget planners to understand more about the risk and uncertainty in the budget, and the extent to which actual results might differ from the expected outcome in the master budget. This can provide valuable information for risk management, and management can assess the 'sensitivity' of their budget to particular estimates and assumptions.

4 BEHAVIOURAL ASPECTS OF BUDGETING

Section overview

- Introduction
- Misunderstanding and worries about cost-cutting
- Opposition to unfair targets set by senior management
- Sub-optimisation
- Budget slack (budget bias)
- Participation in budget setting
- Other behavioural issues
- Management styles

4.1 Introduction

The effectiveness of budgeting and budgetary control depends largely on the behaviour and attitudes of managers and (possibly) other employees.

- Budgets provide performance targets for individual managers. If managers are rewarded for achieving or exceeding their target, budgets could provide them with an incentive and motivation to perform well.
- It has also been suggested that budgets can motivate individuals if they are able to participate in the planning process. Individuals who feel a part of the planning and decision-making process are more likely to identify with the plans that are eventually decided. By identifying with the targets, they might have a powerful motivation to succeed in achieving them.

When budgeting helps to create motivation in individuals, the human aspect of budgeting is positive and good for the organisation.

Unfortunately, in practice human behaviour in the budgeting process often has a negative effect. There are several possible reasons why behavioural factors can be harmful:

- misunderstanding and worries about cost-cutting;
- opposition to unfair targets set by senior management;
- sub-optimisation; or
- budget slack or budget bias.

4.2 Misunderstanding and worries about cost-cutting

Budgeting is often considered by the managers affected to be an excuse for cutting back on expenditure and finding ways to reduce costs. Individuals often resent having 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 have a cost-cutting strategy.

4.3 Opposition to unfair targets set by senior management

When senior managers use the budgeting process to set unrealistic and unfair 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.

A distinction can be made between:

- **aspirational budgets**, which are budgets based on performance levels and targets that senior managers would like to achieve, and
- **expectational budgets**, which are budgets based on performance levels and targets that senior managers would realistically expect to achieve.

Aspirational budgets might be considered unfair, especially if the individuals affected have not been consulted. Expectational budgets, based on current performance levels, do not provide for any improvements in performance.

Ideally perhaps, budgets might be set with realistic targets that provide for some improvements in performance.

4.4 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.

4.5 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 overestimate costs so that it will be much easier to keep actual spending within the budget limit. Similarly, managers may try to underestimate 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.

4.6 Participation in budget setting

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 budget 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; and
- 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.

Factors affecting the impact of participation

The effect of participation on the motivation of subordinates will also depend on circumstances. Hopwood suggested that the effectiveness of participation on employee motivation depends on three key factors.

Factor	Comments
The nature of the task	The effectiveness of participation will depend on the nature of the work, and the extent to which employees have control over the way in which the work is done. *'In highly-programmed … and technically constrained areas, where speed and detailed control are essential for efficiency, participative approaches have less to offer…. In contrast, in areas where flexibility, innovation and the capacity to deal with un-anticipated problems are important, participation in decision-making may offer a more immediate … payoff….'* (Hopwood).
Organisation structure	Participation is likely to be more effective in an organisation where management responsibilities are decentralised, and local managers have more influence over their own budgets.
Personality of the employees	Some types of individual are more likely than others to be motivated by participation in the budgeting process.

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 and 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.

4.7 Other behavioural issues

Performance of operational managers may be measured by comparing actual performance with the budget. The manager might be rewarded for achieving budget targets but criticised for failing to meet the budget.

This tendency to 'blame' managers for failing to meet the budget targets will have an adverse effect on the motivation and attitude of the operational managers in the following circumstances:

- The budget might not make any distinction between costs that are controllable and costs outside the manager's control. The manager might therefore be criticised for excess spending on items over which he has no control.
- Circumstances might change and events might occur that make the original budget unrealistic. Even so, the manager might be criticised for failing to meet the budget targets, even when changed circumstances have made the budget targets unrealistic.

If budgeting is used as a 'performance contract' between the company and its managers, and provides a basis on which the actions by management are assessed, this could lead to a number of problems. Managers will want to avoid criticism, and so meet targets, but they have no obvious incentive to do better than the targets in the budget plan.

Factor	Possible means of dealing with the problem
Meeting only the lowest targets Once a manager has agreed his budget targets for the year, his only incentive is to achieve the budget target, and not to exceed it.	It may be appropriate to introduce an incentive scheme, in which higher bonuses are paid according to the amount by which the budget target is exceeded. Higher bonuses can be paid for better (budget-beating) performance.
Using more resources than necessary Once the budgeted utilisation of resources has been agreed (materials, labour time, machine time and so on) a manager will be satisfied with using the full budgeted quantity of resources permitted. There is no incentive to improve on performance and use fewer resources.	One possibility is to train management and staff in the application of Total Quality Management techniques, so that managers and employees are actively looking for improvements. Another possibility is to provide rewards for achieving variable costs per unit that are less than standard/budgeted.
Earning the bonus – whatever it takes to do this. Managers and employees who are incentivised by a bonus to achieve a budget target will do whatever they can to make the target – even if this means ignoring other aspects of performance for which there is no bonus and even if it means 'bending the rules' to make the target.	This is difficult problem to overcome. The most effective solution may be to amend the rewards system so that there are a number of bonus incentives for achieving a number of different targets. However, this will be difficult to design and implement.

Factor	Possible means of dealing with the problem
Competing with other divisions and departments in the same organisation There will be a tendency for cost centres and profit centres to act competitively towards each other, in order to achieve their own budget target. This may be evident in attitudes to transfer pricing, which are described in another chapter.	If there are disputes between different cost centres, or between cost centres and profit centres, it may be necessary to refer the matter for resolution to the senior management at head office.
Making sure that all the expenditure allocation in the budget is actually spent Managers often see budgeting as a competition for resources and spending allocations. If a cost centre or profit centre does not spend up to its permitted limit in one year, it is at risk of having some of the spending allowance removed the next year. Managers will try to avoid this by making sure that their full budgeted spending allocation is actually spent.	Rewarding employees and managers for achieving lower fixed costs than budgeted may be a solution to this problem.
Providing forecasts that are inaccurate Managers may try to provide forecasts that are (deliberately) not accurate in order to gain an advantage and misrepresent future expectations. There are various reasons why this may be done – for example to persuade senior management to make a decision that is favourable to the forecast provider in order to win a bigger allocation of resources in the budget.	A change in management culture may be necessary to overcome this problem. It is an almost unavoidable feature of management behaviour that forecasts will be presented in the most favourable light possible. It is the task of top management to establish a culture of 'no blame' within the organisation, so that managers may be willing to provide information that is more 'honest'.
Meeting the budget target, but not beating it. If there is no incentive to beat a budget target, managers will be satisfied with simply achieving the target. They may then prefer not to exceed the target so that their target for the following year may not be as challenging as it otherwise might be.	As suggested above, it may be appropriate to have an incentive scheme in which higher bonuses are available according to the amount by which the budget target is exceeded.

Factor	Possible means of dealing with the problem
Avoiding risks Managers will be tempted to stick to the agreed plans in the budget and will be reluctant to take unplanned initiatives that could result in a failure to meet budget targets. Managers may prefer to do nothing wrong than to take risks in order to improve performance.	A bonus system that rewards managers and employees for beating a range of budget targets may be effective, so that managers are prepared to take risks to improve performance. However, as the crisis in the banking system (2007 – 2009) showed, managers should never be encouraged to take on excessive risks.

4.8 Management styles

In the 1970s, research was carried out by Anthony Hopwood into performance evaluation by managers, and how the performance of managers with cost centre responsibility is judged. He identified three types of management style:

- a budget-constrained style;
- a profit-conscious style; and
- a non-accounting style

Budget-constrained style

With this style of management, the performance of managers is based on their ability to meet budget targets in the short term. With this style of performance evaluation, the focus is mainly on budgeted costs actual costs and variances. Managers are under considerable pressure to meet their short-term budget targets. Stress in the job is high. Managers might be tempted to manipulate accounting data to make actual performance seem better in comparison with the budget.

Profit-conscious style

The performance of managers is evaluated on the basis of their ability to increase the general effectiveness of the operations under their management. Increasing general effectiveness means being more successful in achieving the longer-term aims of the organisation. For example, success in reducing costs in the long term would be considered an increase in general effectiveness.

With a profit-conscious style, budgets and variances are not ignored, but they are budgetary control information which is treated with caution, and variances are not given the same importance as with a budget-constrained style.

Hopwood found that with this style of management evaluation, costs remain important, but there is much less pressure and stress in the job. As a consequence, there was a good working relationship between managers and their subordinates. In addition, there was less manipulation of accounting data than with a budget-constrained style.

Non-accounting style

With this style, budgetary control information plays a much less important part in the evaluation of managers' performance. Other (non-accounting) measures of performance were given greater prominence.

Closing comment

The results of empirical research by Hopwood and others (notable David Otley) seem to suggest that the most appropriate approach to the evaluation of performance depends on the circumstances and conditions in which the organisations and their managers operate.

5 BEYOND BUDGETING

Section overview

- Origins of 'beyond budgeting'
- Weaknesses in traditional budgeting
- The 'beyond budgeting model'
- Performance management in the 'beyond budgeting' model
- Beyond budgeting: concluding comments

5.1 Origins of 'beyond budgeting'

The Beyond Budgeting Round Table (BBRT) was set up in 1998. It is a European-wide research project investigating whether entities would benefit from the abolition of budgets and budgeting. The BBRT claims that several successful European companies have stopped preparing budgets. Instead, they use a 'responsibility model' for decision-making and performance measurement. As a result, their performance has improved.

In the UK, the ideas of 'beyond budgeting' are associated with the writing of Jeremy Hope and Robin Fraser.

5.2 Weaknesses in traditional budgeting

Hope and Fraser have argued that the traditional budgeting system is inefficient and inadequate for the needs of modern businesses. In a continually-changing business world, traditional budgeting systems can have the effect of making business organisations fixed and rigid in their thinking, and unable to adapt. As a result, business organisations may be much too slow and inflexible in reacting to business developments.

The budgeting system establishes 'last year's reality' as the framework for the current year's activities. When the business environment is changing rapidly, this approach is inadequate. Managers should respond quickly to changes in the environment, but traditional budgeting and budgetary control systems act as a restraint on innovation and initiative.

Consequences of the inadequacy of the traditional budgeting system are that:

- ❑ operational managers regard the budgeting process as a waste of their time and resent having to prepare and then continually revise budget plans
- ❑ management accountants are involved in the budgetary planning and control system, but their work adds little or no value to the business. As a result, it may be difficult to justify the existence of the management accounting function.

According to the Beyond Budgeting Round Table, there are ten major problems with the traditional budgeting and budgetary control system.

- Budgets are **time-consuming and expensive**. In spite of computer technology and the use of budget models, it can take four to five months in a large company to prepare the annual budget for next year. The work on budget preparation has been found to use over 20% of the time of senior managers and financial controllers.
- **Traditional budgeting adds little value** and uses up valuable management time that could be used better in other ways. Preparing a budget does nothing, or very little, to add value to the entity. Budgets 'are bureaucratic, time-consuming exercises, and the time taken would be better deployed in more value-creating activities' (Hope and Fraser).
- **Fails to consider shareholder value**. The traditional budgeting process focuses too much on **internal matters** and not enough on external factors and the business environment, and it fails to focus on shareholder value.
- **Rigid and inflexible: budgeting systems prevent fast response**. Managers concentrate on achieving 'agreed' budget targets, which may not be in the best interests of the organisation as a whole, particularly when circumstances change after the budget has been agreed. Budgets are therefore 'rigid' and prevent fast and flexible responses to changing circumstances and unexpected events.
- **Budgets 'protect' spending and fail to reduce costs**. In many entities, managers are expected to spend their entire budget allowance. If they don't, money will be taken away from their budget allowance next year. This is certainly no incentive to cut costs.
- Traditional budgeting and budgetary control **discourages innovation**. Managers are required to achieve fixed budget targets, and the fixed budget does not encourage continuous improvement. Managers will be reluctant to exceed their budgeted spending limits, even though extra spending would be necessary to react to events, possibly because spending above budget will put their bonus at risk. In a dynamic business environment, business organisations should be seeking continuous improvement and innovation.
- Budgets **focus on sales targets, not customer satisfaction**. This will possibly increase sales in the short-term, even if the products are not as good as they should be, but long-term success depends on satisfying customers.
- In practice, it has been found that although most companies have a budgeting system, they are poor at executing strategy. This suggests that budgeting systems are not effective systems for implementing strategy.
- Budgeting systems encourage a **culture of 'dependency'**, in which junior managers do what they are told by their boss, and do not argue. 'They reinforce the "command and control" management model and … undermine attempts at organisational change, such as team working, delegation and empowerment' (Hope and Fraser).
- Budgets can lead to 'unethical' behaviour, such as including 'slack' within the budgeted spending allowance.
- There are other major criticisms of budgeting systems.
- Traditional budgeting is seen as a method of imposing financial control, by comparing actual results with budget. Budgeting should be a system for communicating corporate goals – setting objectives and improving performance.
- Budgets are also plans that focus on financial numbers. 'They fail to deal with the most important drivers of shareholder value … - knowledge or intellectual capital. Strong brands, skilled people, excellent management processes, strong leadership and loyal customers are assets that are outside the … accounting system' (Hope and Fraser).

- In many cases, budget plans are not the result of a rational decision-making process. Often, budgets are a political compromise between different departments and managers, and budgeted spending limits for each manager are the outcome of a bargaining process.
- Traditional budgetary control encourages managers to achieve fixed budget targets, but does not encourage continuous improvement. Managers will be reluctant to exceed their budgeted spending limits, even though extra spending would be necessary to react to events, possibly because spending above budget will put their bonus at risk. In a dynamic business environment, business organisations should be seeking continuous improvement and innovation.
- Traditional budgeting shows the costs of departments and functions, but not the costs of activities that are performed by employees. The traditional budget figures do not give managers information about the cost drivers in their business. In addition, traditional budgets do not help managers to identify costs that do not add value.

5.3 The 'beyond budgeting model'

The Beyond Budgeting view is that budgeting, as practised by most companies, should be abolished. The traditional hierarchical form of management structure should also be abolished. In its place, there should be a system in which authority and responsibility is given to operational managers, who should work together to achieve the strategic objectives of the entity.

Traditional budgeting is based on a 'dependency model' of management and organisation culture. It is a system for centralised control by senior management. Control is exercised by requiring operational managers to meet (or exceed) budget targets.

The 'Beyond Budgeting' alternative is a 'responsibility model' in which decision-making and performance management are delegated to 'line managers' (operating managers). Instead of having fixed annual plans, these managers agree performance targets: these targets are reviewed regularly and amended as necessary in response to changing circumstances and unexpected events.

A solution to the lack of flexibility in traditional budgeting may be **continuous rolling forecasting** (or even continuous budgets), so that the business organisation can adapt much more quickly to changes in its environment and to new events.

Responsibility should be delegated to operational managers, who should be empowered to take decisions in response to changing circumstances, that the managers believe would be in the best interests of the organisation.

- Goals should be agreed by reference to external benchmarks (such as increasing market share, or beating the competition in other ways) and targets should not be fixed and internally-negotiated.
- Operational managers should be motivated by the challenges they are given and by the delegation of responsibility.
- Operational managers can use their direct knowledge of operations to adapt much more quickly to changing circumstances and new events.
- Operational managers may be expected to work within agreed parameters, but they are not restricted in their spending by detailed line-by-line budgets.

- Delegated decision-making should encourage more transparent and open communication systems within the organisation. Managers need continuous rolling forecasts to make decisions and apply control. Efficient IT systems are therefore an important element in the 'beyond budgeting' model.

5.4 Performance management in the 'beyond budgeting' model

In the Beyond Budgeting model of performance management, there are 12 basic principles.

- **Governance**. The basis for taking action should be a set of clear values. Mission statements and plans should not be used to guide action.
- **Responsibility for performance**. Managers should be responsible for achieving competitive results, not for meeting the budget target.
- **Delegation**. People should be given the ability and the freedom to act. They should not be controlled and constrained by senior managers.
- **Structure**. Operations should be organised around processes and networks, and should not be organised on the basis of departments and functions.
- **Co-ordination**. There should be effective co-ordination between people within the company, and this should be achieved by process design and fast information systems.
- **Leadership**. Senior managers should challenge and 'coach'. They should not command and control.
- **Setting goals**. The goal should be to beat competitors, not meet budget.
- **Formulating strategy**. Formulating and implementing strategy should be a continuous process, not an annual event imposed by senior management.
- **Anticipatory management**. Management should use anticipatory systems for managing strategy. (Anticipatory systems are systems that provide information about events that are anticipated in the future.)
- **Resource management**. Resources should be made available to operational managers at a fair cost, when they are required. Resources should not be allocated to departments in a fixed budget.
- **Measurement and control**. Performance measurement and control should be based on a small number of key performance indicators, not a large number of detailed reports.
- **Motivation and rewards**. Rewards, at a company level and a business unit level, should be based on competitive performance, not meeting predetermined budget targets.
- Principles (1) to (6) are concerned with establishing an effective organisation and culture of behaviour. Principles (7) to (12) are concerned with establishing an effective system of performance measurement.
- 'Beyond Budgeting entails a shift from a performance emphasis based on numbers to one based on people. It assumes that performance improvement is more likely to come from giving capable people control over decisions (and making them accountable for results), than simply from adopting different measures and incentives' (Hope and Fraser).
- Hope and Fraser set out the 12 principles, and their effect, as follows:

Effective organisation and behaviour		Effective performance		Management of competitive success
Clear values		Relative targets		Fast response
Responsibility for results		Adaptive strategies		Best people
Freedom and capability to act	×	Anticipatory management	=	Innovative strategies
Fast networks and processes		Internal market for resources		Low costs
Co-ordination		Fast, distributed controls		Loyal customers
Challenge and stretch		Relative team rewards		Satisfied customers

To compete successfully, management has to be very good at the six issues in the box on the right-hand side of this diagram.

- They must create a climate and culture for fast response. An ability to respond quickly to unexpected changes and events will mean that the company can deal with uncertainty successfully. Change should be seen as an opportunity, not a threat.
- Managers must be given responsibility for strategy, and they should monitor strategy continuously, not just once a year (as in the traditional budget model).
- If new initiatives are needed, managers should be able to obtain the resources they need quickly. 'They need, for example, the authority to acquire key people when they are available (not when there is room in the budget); to react to competitive threats and opportunities as they arise (not as predicted in an outdated plan); and to acquire and deploy resources when necessary (not as allocated by head office)' (Hope and Fraser).
- They must employ the best people. A challenging environment to work in is likely to attract and retain top-quality employees.
- They must innovate and generate new business ideas. Bureaucracy does not encourage innovation and creativity. The 'Beyond Budgeting' model does.
- They must operate with low costs. Competitive pressures in markets are forcing down prices. In the 'Beyond Budgeting' model managers will adapt strategies to the requirements of the competitive environment, and will find ways to reduce costs if this is appropriate. The traditional budgeting model does not encourage effective cost reduction.
- They must create and retain loyal customers. The 'Beyond Budgeting' model encourages managers to focus on satisfying customer needs. Satisfied customers are likely to be loyal customers.
- They must create value for shareholders. The 'Beyond Budgeting' model should help a company to improve its profitability and create additional value for its shareholders.

5.5 Beyond budgeting: concluding comments

Hope and Fraser have argued that traditional budgeting systems are weak and should not be used. However, in practice most companies and other organisations continue to use them.

It has been argued that the 'beyond budgeting' model is much more easily applied in the private sector than in the public sector. Government activity is managed through expenditure budgets and spending controls, and there is accountability for spending to politicians (government ministers and elected representatives) and to the general public. There may also be uncertainty about the objectives of particular government activities or departments. In such circumstances, it is difficult to apply a flexible system of decision-making or to devolve decision-making to lower levels of management.

There have been attempts to improve traditional budgeting systems: for example, zero based budgeting, continuous budgets and activity based budgeting are all attempts to improve the budgeting system. Hope and Fraser argue, however, that these are 'valiant efforts to update the process, but they only deal with part of the [problem] and are both time-consuming and complicated to manage.'

6 FORECASTING

Section overview

- The nature of a time series
- Analysing a time series
- Moving averages
- Centred moving averages
- Line of best fit
- Seasonal variations

6.1 The nature of a time series

A time series is a record of data over a period of time, for example, sales revenue per month or revenue per quarter. The time series is a convenient way of representing historical information but more importantly it might be used to make predictions about the future. This is done by continuing the series forward in time. In order to do this, the time series must be analysed into its component parts.

Components of a time series

A change in value of an observed variable in a time series might be due to a combination of factors. These are described as the components of the time series. There are two models of a time series which differ in how these components are linked together.

Formula: Time series models

Additive model:

$$YA = T + S + C + R$$

Proportional (multiplicative model)

$$YM = T \times S \times C \times R$$

Where:

T = Trend – the overall direction of change in the data.

S = Seasonal variation – differences between the actual data observed for a time period and the amount predicted by the trend for that period.

C = Cyclical variation – Longer term variations which might cause changes over longer periods.

R = Random fluctuations

Note that the term “seasonal variation” has a specific meaning in time series analysis. It relates to the variation in each period covered in the analysis. Therefore it could mean a daily, weekly, quarterly or annual variation depending on the analysis.

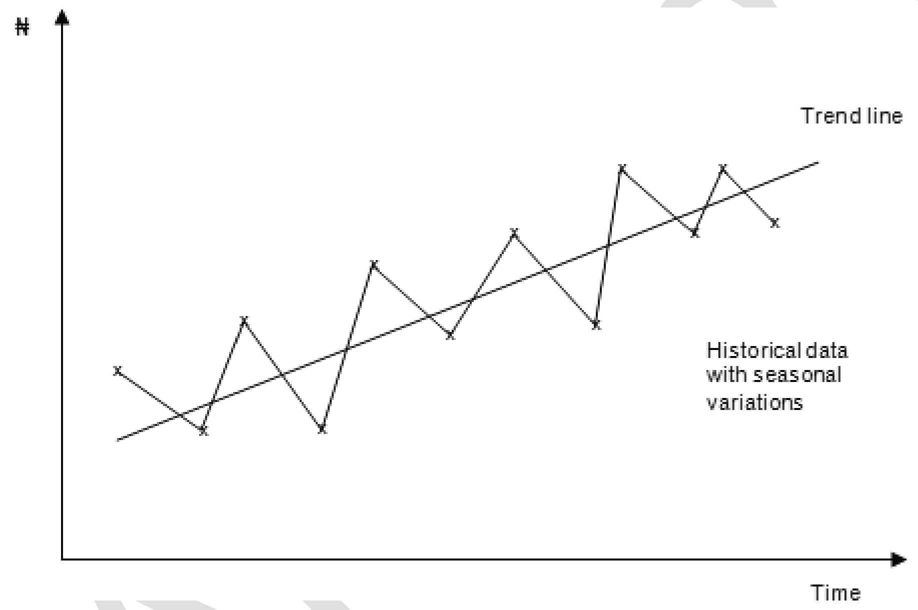
Questions requiring analysis of a time series will require the identification of a trend and seasonal variations.

- Random fluctuations cannot be predicted. The usual assumption made is that they are negligible and can be ignored in any analysis.
- Also, there is usually insufficient data to identify cyclical variations.

The plot of a time series as a graph is called a historigram.

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.

Illustration: Historigram of a time series



6.2 Analysing a time series

There are two aspects to analysing a time series from historical data:

- estimating the trend line; and
- calculating the amount of the seasonal variations (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:

- Moving averages.
- Linear regression analysis.

Linear regression analysis is a technique that produces a line of best fit for observed data. This was covered in an earlier chapter (along with the high/low method which can also be used in forecasting). Note that both might be used together. Moving averages might be used to identify the underlying trend and then linear regression might be used to identify a line of best fit for the moving averages identified.

Methods of calculating seasonal variations are explained later.

6.3 Moving averages

Moving averages can be used to estimate a trend line, particularly when there are seasonal variations in the data.

The technique involves smoothing out fluctuations in the underlying observed data by calculating averages for small groups of observations from that data. The size of the small group is related to the type of data. If the data is quarterly then a group of 4 would be used or if the data was monthly a group of 12 would be used.

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.

- ❑ The cycle might be seven days when historical data is collected daily for each day of the week or perhaps six days if the business is closed for one day per 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. This represents an amount for the middle day in the data i.e. day 4.
- ❑ Another moving average can be calculated for Day 2 – Day 8. . This represents an amount for the middle day in the data i.e. day 5.

This process continues until all of the data have been included. Note that as this is an averaging process it results in a figure related to the mid-point of the overall period for which the average has been calculated.

Note that it is easier to number each day, month or quarter in a cycle starting from 1 rather than retain actual day names, dates etc.

Step 3: If there is an even number of items of data in the moving average calculation, then the average will correspond to a point between the middle two time periods. A second average is calculated for each pair of values in the moving average column. This is done to centre the observation and align it with a time period.

For example:

- ❑ A moving average for Quarter 1 – Quarter 4 gives a value which represents the mid-point of the range. This is Quarter 2.5.
- ❑ A moving average for Quarter 2 – Quarter 5 gives a value which represents the mid-point of the range. This is Quarter 3.5.
- ❑ Quarters 2.5 and 3.5 do not exist so the values are averaged to give a value which is taken to represent Quarter 3.

Step 4: Use the moving averages (and their associated time periods) to calculate a trend line.

The following example illustrates the calculation of moving average in detail to ensure that you understand what it means before moving on to produce a complete trend.

Example: Calculating moving averages

A company operates for five days each week. Sales data for the most recent three weeks are as follows:

Sales	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
	units	units	units	units	units
Week 1	78	83	89	85	85
Week 2	88	93	99	95	95
Week 3	98	103	109	105	105

Moving averages are calculated as follows:

Day	**Sales**				
1	78				
2	83				
3	89	=	420	÷ 5 days	= 84 per day
4	85				
5	85				

84 represent the sales on the middle day of the period (day 3)

Day	**Sales**				
2	83				
3	89				
4	85	=	430	÷ 5 days	= 86 per day
5	85				
6	88				

86 represents the sales on the middle day of the period (day 4)

The example is continued to complete the trend on the next page.

Example: Constructing a trend line with moving averages

A company operates for five days each week. Sales data for the most recent three weeks are as follows:

Sales	Monday	Tuesday	Wednesday	Thursday	Friday
	units	units	units	units	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. Moving averages are calculated for five-day periods, as follows:

Day	Sales	5 day total	Moving average (trend found by dividing the 5 day total by 5)
Day 1	78		
Day 2	83		
Day 3	89	420	84
Day 4	85	430	86
Day 5	85	440	88
Day 6	88	450	90
Day 7	93	460	92
Day 8	99	470	94
Day 9	95	480	96
Day 10	95	490	98
Day 11	98	500	100
Day 12	103	510	102
Day 13	109	520	104
Day 14	105	530	
Day 15	105	540	

Note that this process always results in a loss of values for points in time at the start and at the end of the range.

Line of best fit

The trend is an indication of the general movement in a set of data. In order to make predictions, the trend must be expressed as a straight line.

In the above example, the trend increases by 2 each day. This means that each moving average actually lies on a straight line. An equation can be found for this trend line by taking the first sales figure as a starting point and then adjusting it by the number of days multiplied by 2 per day to give the following formula:

Daily sales = 78 + 2x.

This trend line can be used to forecast a trend value for any day in the future. For example, the forecast for sales on day 50 is:

Daily sales = 78 + 50x = 178

This of course assumes that sales will continue to grow at 2 per day on average.

This trend line can also be used to calculate the 'seasonal variations' (in this example, the daily variations in sales can be above or below the trend).

In turn, these can be used to adjust the forecast value of the trend line to take account of whether day 50 is a Monday, Tuesday, Wednesday, Thursday or Friday.

This is explained later.

6.4 Centred moving averages

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 in order to arrive at a value which corresponds to an actual season of the year.

Example: Constructing a trend line with centred moving averages

The following quarterly sales figures have been recorded for a company.

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

In the following analysis, the quarters are numbered from 1 to 12 for ease of reference. (Thus year 1: Q1 is numbered Q1 and year 3: Q4 is numbered Q12).

Moving average values for each quarter are calculated as follows:

Quarter	Sales	4 quarter total	Moving average (trend found by dividing the 4 quarter total by 4)
1	20		
2	24		
		102	25.5
3	27		
		117	29.25
4	31		
		132	33.00
5	35		
		149	37.25
6	39		
		165	41.25
7	44		
		179	44.75
8	47		
		196	49.00
9	49		
		212	53.00
10	56		
		229	57.25
11	60		
12	64		

Each of the moving average figures above line up opposite a point between two quarters (seasons). For example, the average for quarters 1 to 4 sits between quarter 2 and quarter 3 at quarter 2.5.

Analysing seasonal variation requires the figures in the trend to be lie opposite an actual season (quarter). This is achieved by carrying out a second averaging for each adjacent pair of numbers. The resultant numbers are called centred moving averages

Example: Constructing a trend line with centred moving averages (continued)

Quarter	Sales	Moving average	Centre total (of 2 moving averages)	Centred moving average (÷2)
1	20			
2	24			
		25.5		
3	27		25.5 + 29.25 = 54.75	**27.38**
		29.25		
4	31		29.25 + 33.00 = 62.25	**31.13**
		33.00		
5	35		33.00 + 37.25 = 70.25	**35.13**
		37.25		
6	39		37.25 + 41.25 = 78.50	**39.25**
		41.25		
7	44		41.25 + 44.75 = 86.00	**43.00**
		44.75		
8	47		44.75 + 49.00 = 93.75	**46.88**
		49.00		
9	49		49.00 + 53.00 = 102	**51.00**
		53.00		
10	56		53.00 + 57.25 = 110.25	**55.13**
		57.25		
11	60			
12	64			

The moving averages in the right hand column correspond to an actual season (quarter). These moving averages are used to estimate the trend line and the seasonal variations.

6.5 Line of best fit

As explained earlier, the trend is an indication of the general movement in a set of data but in order for it to be used to make predictions, it must be expressed as a straight line.

The first moving average value can be used as a starting point in the equation of a straight line. One way of identifying the slope is to subtract the lowest moving average from the highest and divide the figure by the number of periods between those two figures.

Example: Line of best fit

From the previous example

	Moving average
Quarter 10	55.13
Quarter 3	(27.38)
	27.75
Number of periods between Q10 and Q3	÷7
	3.96

The equation of the line of best fit is:

y (Sales) = 27.38 + 3.96x

Care must be taken in using this equation. Remember the starting point for the equation is Q3 so any value must be calculated in reference to Q3.

Example: Line of best fit

From the previous example estimate the trend sales figure for Q4 in year 4.

This corresponds to Q16 in the example which is 13 quarters after the starting point.

y (Sales) = 27.38 + 3.96x

y (Sales in Q4 of year 4) = 27.38 + 3.96 (13) = 78.86

6.6 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.

Consider 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 trend value.

The seasonal variation is then used to adjust a forecast trend value.

There are two models used to estimate seasonal variation:

- The additive model;
- The proportional model.

The additive model

This model assumes that 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.

The seasonal variation for each season (or daily variation for each day) is estimated as follows, when the additive assumption is used:

- Calculate the difference between the moving average value and the actual historical figure for each time period.
- Group these seasonal variations into the different seasons of the year (days of the week; months or quarters of the year).
- Calculate the average of these seasonal variations for each season (or day; month; quarter).
- if the total seasonal variations for the cycle do not add up to zero the difference is spread evenly across each season (or day; month; quarter).
- This adjusted figure is the seasonal variation.

Example: Additive model

Using the previous example for quarterly sales, actual sales and the corresponding moving average value were as follows:

Quarter	Trend	Actual sales in the quarter	Variation (Actual – Moving average)
Year 1: Q3	27.375	27	–0.375
Year 1: Q4	31.125	31	–0.125
Year 2: Q1	35.125	35	–0.125
Year 2: Q2	39.250	39	–0.250
Year 2: Q3	43.000	44	1.000
Year 2: Q4	46.875	47	0.125
Year 3: Q1	51.000	49	–2.000
Year 3: Q2	55.125	56	0.875

The seasonal variation (daily variation) is now calculated as the average seasonal variation for each day, as follows:

Variation	Q1	Q2	Q3	Q4	Total
Year 1			–0.375	–0.125	
Year 2	–0.125	–0.250	1.000	0.125	
Year 3	–2.000	0.875			
Average	–1.063	0.313	0.313	0.0	–0.437
Adjustment:	0.10925	0.10925	0.10925	0.10925	0.437
Seasonal adjustment	–0.95375	0.42225	0.42225	0.10925	0

The seasonal variations can then be used, with the estimated trend line, to make forecasts for the future.

Example: Forecast sales

The forecast for the trend value of sales in Q4 in year 4 is 78.86.

The estimated sales in this quarter are:

Trend value	78.86
Quarter 4 adjustment (rounded)	0.11
Sales forecast	78.97

The proportional model

This model expresses the actual value in each season as a proportion of the trend line value.

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.

The sum of the proportions for each time period must add up to 1. This means that the total of the proportions quarterly data must sum to 4. If this is not the case the difference is spread evenly over each quarter

Example: Proportional model

Using the previous example for quarterly sales, actual sales and the corresponding moving average value were as follows:

Quarter	Trend	Actual sales in the quarter	Seasonal variation: actual sales as a proportion of the moving average
Year 1: Q3	27.375	27	0.986
Year 1: Q4	31.125	31	0.996
Year 2: Q1	35.125	35	0.996
Year 2: Q2	39.250	39	0.994
Year 2: Q3	43.000	44	1.023
Year 2: Q4	46.875	47	1.003
Year 3: Q1	51.000	49	0.961
Year 3: Q2	55.125	56	1.016

The seasonal variation (daily variation) is now calculated as the average seasonal variation for each day, as follows:

Variation	Q1	Q2	Q3	Q4	Total
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	3.985
	0.00375	0.00375	0.00375	0.00375	0.015
	0.98175	1.00775	1.00775	1.00275	4.000

Example: Forecast sales

The forecast for the trend value of sales in Q4 in year 4 is 78.86.

The estimated sales in this quarter are:

Trend value	78.86
Quarter 4 adjustment (rounded)	×1.003
Sales forecast	79.01

7 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the purposes of budgeting and the budgeting process
- Describe the main features of, and explain the differences between bottom-up and top-down budgeting
- Explain incremental and zero-based budgeting
- Explain activity based budgeting (ABB)
- Recognise and explain the importance of the behavioural aspects of budgeting
- Discuss beyond budgeting as a concept
- Explain and apply forecasting techniques

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

Sales budget

Product	Budgeted sales quantity	Budgeted sales price	Budgeted sales revenue
	units	₦	₦
X	2,500	410	1,025,000
Y	3,200	400	1,280,000
Total			2,305,000

Production budget

	Product X	Product Y
	units	units
Sales budget	2,500	3,200
Budgeted closing inventory	200	100
	2,700	3,300
Opening inventory	300	150
Production budget	2,400	3,150

Material usage budget

	A (kgs)	B (kgs)	C (kgs)
Usage to make 2,400 units of X			
2,400 units × 1 kgs	2,400		
2,400 units × 0.75 kgs		1,800	
2,400 units × 2 kgs			4,800
Usage to make 3,150 units of Y			
3,150 units × 1 kgs	3,150		
3,150 units × 0.5 kgs		1,575	
3,150 units × 3 kgs			9,450
Usage in kgs	5,550	3,375	14,250
Cost per kg	₦30	₦80	₦30
Usage in naira	166,500	270,000	427,500
Total cost			₦864,000

Solution (continued) **1**

Material purchases budget

	A (kgs)	B (kgs)	C (kgs)
Usage	5,550	3,375	14,250
Closing inventory	380	400	120
	5,930	3,775	14,370
Opening inventory	(400)	(450)	(150)
Purchases (kgs)	5,530	3,325	14,220
Cost per kg (₦)	₦30	₦80	₦30
Purchases (₦)	165,900	266,000	426,600
Total cost			₦858,500

Labour usage budget

	Grade I (hrs)	Grade II (hrs)
Usage to make 2,400 units of X		
2,400 units × 1 hr	2,400	
2,400 units × 1.5 hrs		3,600
Usage to make 3,150 units of Y		
3,150 units × 0.8 hrs	2,520	
3,150 units × 1 hr		3,150
Usage in kgs	4,920	6,750
Cost per kg (₦)	100	80
Usage in naira	492,000	540,000
Total cost(₦)		1,032,000

Solution (continued) **1**

Budgeted profit or loss account

	₦	₦
Sales budget		2,305,000
Cost of sales:		
Opening inventory	211,500	
Purchases	858,500	
Labour usage	1,032,000	
	2,102,000	
Closing inventory	(153,000)	
		(1,949,000)
Budgeted gross profit		356,000

The budgeted gross profit can be checked as follows:

	(Units × (Sales price – Unit cost)	₦
Profit from selling X	(2,500 units × (410 – 370))	100,000
Profit from selling Y	(3,200 units × (400 – 320))	256,000
		356,000

Skills level
Performance management

CHAPTER 7

Variance analysis

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

B	**Planning and control**			
	2	**Variance analysis**		
		A	Explain the uses of standard cost and types of standard.	
		B	Discuss the methods used to derive standard cost.	
		C	Explain and analyse the principle of controllability in the performance management system.	
		D	Calculate and apply the following variances:	
			i	Material usage and price variances;
			iii	Labour rate, efficiency and idle time variances;
			iv	Variable overhead expenditure and efficiency variances;
			v	Fixed overhead budget, volume, capacity and productivity variances;
			vi	Sales volume variance;
		E	Identify and explain causes of various variances and their inter-relationship.	
		F	Analyse and reconcile variances using absorption and marginal costing techniques	

Exam context

This chapter explains the techniques of variance analysis.

The chapter explains that a flexed budget shows what would have been achieved based on the actual level of activity but assuming revenue per unit and all costs per unit have been the same as budgeted. It is a new budget drawn up for the actual levels of unit sales and unit output.

Variance analysis reconciles the difference between the budgeted profit figure and that actually achieved. This reconciliation occurs in two steps. The difference between the original budgeted profit and the flexed budgeted profit is shown as a volume variance. The differences between the flexed budget and the actual results are shown in detail.

By the end of this chapter, you should be able to:

- Explain standard costing using examples
- Explain and construct a flexed budget
- Calculate sales volume variance

- Calculate, analyse and interpret various variances relating to material, labour and factory overhead(both variable and fixed)
  Prepare an operating statement reconcile budgeted profit to actual profit using total absorption costing (TAC) and marginal costing (MC)

1 STANDARD COSTS

Section overview

- Standard units of product or service
- Standard cost
- Standard costing
- The uses of standard costing
- Deriving a standard cost
- Types of standard
- Reviewing standards

1.1 Standard units of product or service

Standard costing involves using an expected cost (standard cost) as a substitute for actual cost in the accounting system. Periodically the standard costs are compared to the actual costs. Differences between the standard and actual are recorded as variances in the costing system.

When is standard costing appropriate?

Standard costing can be used in a variety of situations.

It is most useful when accounting for homogenous goods produced in large numbers, when there is a degree of repetition in the production process.

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

Definition: Standard cost and standard costing

Standard cost is an estimated or predetermined cost of performing an operation or producing a good or service, under normal conditions

Standard costing is a control technique that reports variances by comparing actual costs to pre-set standards so facilitating action through management by exception.

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: Standard cost card

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	
		21.00
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		98.00

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.

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 will 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.

Companies can often measure the standard quantities with a high degree of confidence. Remember that standard costing is appropriate in conditions of high production numbers and a lot of repetition. Companies might make thousands of items and this experience leads to knowledge of the process.

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.

Example: Deriving a standard cost

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	₦40 per unit
Direct material B	₦30 per unit
Direct labour	₦200 per hour
Variable production overhead	₦40 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 × ₦40)	80	(1.5 units × ₦40)	60
Material B	(1 unit × ₦30)	30	(3 units × ₦30)	90
Direct labour	(0.75 hours × ₦200)	150	(1 hour × ₦200)	200
Variable production overhead	(0.75 hours × ₦40)	30	(1 hour × ₦40)	40
Standard variable prod'n cost		290		390
Fixed production overhead	(0.75 hours × ₦48)	36	(1 hour × ₦48)	48
Standard full production cost		326		438

Practice question **1**

A company manufactures two products, L and H. In Year 1, it budgets to make 6,000 units of Product L and 2,000 units of Product H. Budgeted resources per unit and costs are as follows:

	L	H
Direct materials per unit:		
Material X	3 kg	1kg
Material Y	2 kg	6 kg
Direct labour hours per unit	1.6 hours	3 hours

Costs	
Direct material X	₦30 per unit
Direct material Y	₦40 per unit
Direct labour	₦250 per hour
Variable production overhead	₦50 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 ₦1,800,000 for the year.

Required

Calculate the standard full production cost per unit of:

(a) Product L, and

(b) Product H

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 become 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.

2 INTRODUCTION TO VARIANCE ANALYSIS

Section overview

- Standard cost cards
- Fixed budget
- Flexed budget
- Comparison of actual results to the flexed budget
- Cost variances

2.1 Standard cost cards

Standard costs are constructed by estimating the quantities of standard amounts of input (for example materials and labour) and estimating the cost of buying these over the future period covered by the standard.

Standard costs for a unit are often set out in a record called a standard cost card. A typical standard cost card is as follows.

Example: Standard cost card (Lagos Manufacturing Limited)

		₦
Direct materials	5 kg @ ₦1,000 per kg	5,000
Direct labour	4 hours @ ₦500 per hour	2,000
Variable overhead	4 hours @ ₦200 per hour	800
Marginal production cost		7,800
Fixed production overhead	4 hours @ ₦600 per hour	2,400
Total absorption cost		10,200

The above standard costs will be used in examples throughout this chapter to illustrate variance analysis.

Standard costs link to the budget through activity levels.

For example, if a company wanted to make 1,200 of the above units the budget would show a material cost of ₦6,000,000 (1,200 × ₦5,000)

Example: Fixed budget for a period

Lagos Manufacturing Limited has budgeted to make 1,200 units.

Cost budget		₦'000
Materials	(1,200 units ×₦5,000 per unit)	6,000
Labour	(1,200 units × ₦2,000 per unit)	2,400
Variable overhead	(1,200 units × ₦800 per unit)	960
Fixed overhead	(1,200 units × ₦2,400 per unit)	2,880

2.2 Fixed budget

The original budget prepared at the beginning of a budget period is known as the fixed budget. A fixed budget is a budget for a specific volume of output and sales activity, and it is the ‘master plan’ for the financial year that the company tries to achieve.

Example: Fixed budget for a period

Lagos Manufacturing Limited has budgeted to make 1,200 units and sell 1,000 units in January.

The selling price per unit is budgeted at ₦15,000.

The standard costs of production are as given in the previous example.

The budget prepared for January is as follows:

Unit sales	1,000
Unit production	1,200

Budget		₦‘000
Sales	(1,000 units × 15,000)	15,000
Cost of sales:		
Materials	(1,200 units ×₦5,000 per unit)	6,000
Labour	(1,200 units × ₦2,000 per unit)	2,400
Variable overhead	(1,200 units × ₦800 per unit)	960
Fixed overhead	(1,200 units × ₦2,400 per unit)	2,880
		12,240
Closing inventory	(200 units × ₦10,200 per unit)	(2,040)
Cost of sales	(1,000 units × ₦10,200 per unit)	(10,200)
Profit		4,800

Note:

Budgeted profit = 1,000 units × (₦15,000 – ₦10,200 per unit) = ₦4,800,000

One of the main purposes of budgeting is budgetary control and the control of costs. Costs can be controlled by comparing budgets with the results actually achieved.

Differences between expected results and actual results are known as variances. Variances can be either favourable (F) or adverse (A) depending on whether the results achieved are better or worse than expected.

Consider the following:

Example: Fixed budget and actual results for a period.

At the end of January Lagos Manufacturing Limited recorded its actual results as follows.

	Budget	**Actual**
Unit sales	1,000	900
Unit production	1,200	1,000

	Budget	**Actual**
Budget	₦'000	₦'000
Sales	15,000	12,600
Cost of sales:		
Materials	6,000	4,608
Labour	2,400	2,121
Variable overhead	960	945
Fixed overhead	2,880	2,500
	12,240	10,174
Closing inventory	(2,040)	(1,020)
Cost of sales	(10,200)	(9,154)
Profit	4,800	3,446

Note:

The actual closing inventory of 100 units is measured at the standard cost of ₦10,200 per unit. This is what happens in standard costing systems.

What does this tell us?

The actual results differ from the budget. The company has not achieved its plan in January. Profit is less than budgeted. The company would like to understand the reason for this in as much detail as possible.

The technique that explains the difference between actual results and the budget is called variance analysis. This technique identifies the components of the difference between the budgeted profit and the actual profit in detail so that they can be investigated and understood by the company.

The sales figure is less than budgeted but why? The sales figure is a function of the quantity sold and the selling price per unit. The quantity sold is 100 units less than budgeted but what about the impact of any difference in the sales price?

At first sight it looks as if the company has made savings on every cost line. For example budgeted material cost was ₦6,000,000 but actual spend was only ₦4,608,000. However, this is not a fair comparison because the budgeted cost was to make 1200 units whereas the company only made 1,000 units.

2.3 Flexed budget

Variances are not calculated by comparing actual results to the fixed budget directly because the figures relate to different levels of activity and the comparison would not be like to like. A second budget is drawn up at the end of the period. This budget is based on the actual levels of activity and the standard revenue and standard costs. This budget is called a flexed budget.

Example: Flexed budget for a period

The flexed budget prepared by Lagos Manufacturing Limited at the end of January (based on actual levels of activity and standard revenue per unit and standard cost per unit) is as follows:

Unit sales	900
Unit production	1,000

Budget		₦'000
Sales	(900 units × 15,000)	13,500
Cost of sales:		
Materials	(1,000 units ×₦5,000 per unit)	5,000
Labour	(1,000 units × ₦2,000 per unit)	2,000
Variable overhead	(1,000 units × ₦800 per unit)	800
Fixed overhead	(1,000 units × ₦2,400 per unit)	2,400
		10,200
Closing inventory	(100 units × ₦10,200 per unit)	(1,020)
Cost of sales	(900 units × ₦10,200 per unit)	(9,180)
Profit		4,320

This shows the amount that the company would have received for the actual number of units sold if they had been sold at the budgeted revenue per item.

It shows what the actual number of units produced (1,000 units) would have cost if they had been made at the standard cost.

The flexed budget is a vital concept. It sits at the heart of variance analysis.

2.4 Comparison of actual results to the flexed budget

All three statements can be combined as follows:

Example: Fixed budget, flexed budget and actual results for a period.

At the end of January, Lagos Manufacturing Limited has recorded its actual results as follows (together with the original fixed budget and the flexed budget for the month).

	Fixed budget	Flexed budget	Actual
Unit sales	1,000	900	900
Unit production	1,200	1,000	1,000
	Budget	**Actual**	**Actual**
Budget	₦‘000	₦‘000	₦‘000
Sales	15,000	13,500	12,600
Cost of sales:			
Materials	6,000	5,000	4,608
Labour	2,400	2,000	2,121
Variable overhead	960	800	945
Fixed overhead	2,880	2,400	2,500
	12,240	10,200	10,174
Closing inventory	(2,040)	(1,020)	(1,020)
Cost of sales	(10,200)	(9,180)	(9,154)
Profit	4,800	4,320	3,446

Note:

The actual closing inventory of 100 units is measured at the standard total absorption cost of ₦10,200 per unit. This is what happens in standard costing systems.

The information for Lagos Manufacturing Limited’s performance in January will be used throughout this chapter to illustrate variance analysis.

Note that the above example is unlikely to be something that you would have to produce in the exam. It is provided to help you to understand what variance analysis is about.

Commentary

Variance analysis explains the difference between the fixed budget profit and the actual profit in detail. This paragraph provides an initial commentary before looking at the detailed calculations in later sections of this chapter.

Both the fixed budget and the flexed budget are based on the standard revenue per unit and the standard costs per unit. Therefore, the difference between the fixed budget and the flexed budget is caused only by difference in volume. This figure of ₦480,000 (₦4,800,000 – ₦4,320,000) is called the sales volume variance. This is revisited in detail later in this chapter.

Revenue is sales quantity × sales price per unit. The revenue in the flexed budget and the actual revenue are both based on the actual quantity sold. Therefore the difference between the two figures of ₦900,000 (₦13,500,000 − ₦12,600,000) is due to a difference in the selling price per unit. This difference is called the sales price variance. This is revisited in detail later in this chapter.

The difference between each variable cost line in the flexed budget and the equivalent actual figure is a total cost variance for that item. For example the actual results show that 1,000 units use material which cost ₦4,608,000. The flexed budget shows that these units should have used material which cost ₦5,000,000. The difference of ₦392,000 is due to a combination of the actual material used being different to the budgeted usage of 5kgs per unit and the actual price per kg being different to the budgeted price per kg. In other words, the total variance can be explained in terms of usage and price. This is explained in detail later in this chapter.

Variable cost variances can be calculated for all items of variable cost (direct materials, direct labour and variable production overhead). The method of calculating the variances is similar for each 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 variance is calculated in two parts, that add up to the total cost variance:
  - a price variance or rate variance or expenditure per hour variance.
  - a usage or efficiency variance.

The difference between the fixed overhead in the flexed budget and the actual fixed overhead is over absorption. This was covered in an earlier chapter but will be revisited in full later in this chapter.

2.5 Cost variances

Adverse and favourable cost variances

In a standard costing system, all units of output are valued at their standard cost. Cost of production and 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) or unfavourable (U).
- When actual cost is less than standard cost, the cost variance is favourable (F).

Different variances are calculated, relating to direct materials, direct labour, variable production overhead and fixed production overhead. (There are also sales variances. These are explained in a later section.)

In a cost accounting system, cost variances are adjustments to the profit in an accounting period.

- Favourable variances increase the reported profit.
- Adverse variances reduce the reported profit.

The method of calculating cost variances is similar for all variable production cost items (direct materials, direct labour and variable production overhead).

A different method of calculating cost variances is required for fixed production overhead.

Variances and performance reporting

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.

Variances might be reported in a statement for the accounting period that reconciles the budgeted profit with the actual profit for the period. This statement is known as an **operating statement**.

3 DIRECT MATERIALS VARIANCES

Section overview

- Direct materials: total cost variance
- Direct materials price variance
- Direct materials usage variance
- Alternative calculations
- Direct materials: possible causes of variances

3.1 Direct materials: total cost variance

The total direct material cost variance is the difference between the actual material cost in producing units in the period and the standard material cost of producing those units.

Illustration: Direct materials – total cost variance

	₦
Standard material cost of actual production:	
Actual units produced × Standard kgs per unit × Standard price per kg	X
Actual material cost of actual production:	
Actual units produced × Actual kgs per unit × Actual price per kg	(X)
	X

The variance is adverse (A) if actual cost is higher than the standard cost, and favourable (F) if actual cost is less than the standard cost.

Example: Direct material – Total cost variance (Lagos Manufacturing Limited)

Standard material cost per unit: (5kgs × ₦1,000 per kg) = ₦5,000 per unit

Actual production in period = 1,000 units.
Materials purchased and used: 4,850 kgs at a cost of ₦4,608,000

Direct materials total cost variance is calculated as follows:

	₦'000
Standard: 1,000 units should cost (@ ₦5,000 per unit)	5,000
Actual: 1,000 units did cost	(4,608)
Total cost variance	392 **F**

The direct materials total cost variance can be analysed into a price variance and a usage variance.

- A price variance measures the difference between the actual price paid for materials and the price that should have been paid (the standard price).
- A usage variance measures the difference between the materials that were used in production and the materials that should have been used (the standard usage).

Practice question **2**

A unit of Product P123 has a standard cost of 5 litres of Material A at ₦3 per litre. The standard direct material cost per unit of Product P123 is therefore ₦15.

In a particular month, 2,000 units of Product P123 were manufactured. These used 10,400 litres of Material A, which cost ₦33,600.

Calculate the total direct material cost variance.

3.2 Direct materials price variance

The price variance may be calculated for the materials purchased or materials used. Usually it is calculated at the point of purchase as this allows the material inventory to be carried at standard cost.

Illustration: Direct materials – price variance

	₦
Standard material cost of actual production:	
Actual kgs purchased × Standard price per kg	X
Actual material cost of actual purchases	
Actual kgs purchased × Actual price per kg	(X)
	X

Example: Direct materials – price variance (Lagos Manufacturing Limited)

Standard material cost per unit: (5kgs × ₦1,000 per kg) = ₦5,000 per unit

Actual production in period = 1,000 units.

Materials purchased and used: 4,850 kgs at a cost of ₦4,608,000

Direct materials price variance is calculated as follows:

	₦'000
Standard: 4,850 kgs should cost (@ ₦1,000 per kg)	4,850
Actual: 4,850 kgs did cost	(4,608)
Materials price variance	242 **F**

If there are two or more direct materials, a price variance is calculated separately for each material.

Practice question **3**

A unit of Product P123 has a standard cost of 5 litres of Material A at ₦3 per litre. The standard direct material cost per unit of Product P123 is therefore ₦15. In a particular month, 2,000 units of Product P123 were manufactured. These used 10,400 litres of Material A, which cost ₦33,600.

Calculate the direct material price variance.

3.3 Direct materials usage variance

The usage variance is calculated by comparing the actual quantity of material used to make the actual production to the standard quantity that should have been used to produce those units. In other words, the actual usage of materials is compared with the standard usage for the actual number of units produced,

The difference is the usage variance, measured as a quantity of materials. This is converted into a money value at the standard price for the material.

Illustration: Direct materials – Usage variance

	Kgs
Standard quantity of material needed to make the actual production	X
Actual quantity of material used to make the actual production	(X)
Usage variance (in kgs)	X
Standard cost per kg (multiply by)	X
Usage variance (₦)	X

Example: Direct materials – Usage variance (Lagos Manufacturing Limited)

Standard material cost per unit: (5kgs × ₦1,000 per kg) = ₦5,000 per unit

Actual production in period = 1,000 units.

Materials purchased and used: 4,850 kgs at a cost of ₦4,608,000

Direct materials usage variance is calculated as follows:

	Kgs
Standard:	
Making 1,000 units should have used (@ 5 kgs per unit)	5,000
Actual: Making 1,000 units did use	(4,850)
Usage variance (kgs)	150 **F**
Standard cost per kg	₦1,000
Usage variance (₦)	₦150,000 **F**

Practice question **4**

A unit of Product P123 has a standard cost of 5 litres of Material A at ₦3 per litre.

The standard direct material cost per unit of Product P123 is therefore ₦15. In a particular month, 2,000 units of Product P123 were manufactured.

These used 10,400 litres of Material A, which cost ₦33,600.

Calculate the direct materials usage variance.

3.4 Alternative calculations

Variances can be calculated in a number of ways. A useful approach is the following line by line approach.

Formula: Alternative method for calculating material variances

$AQ_{purchased} \times AC$	X		
		X	Price variance
$AQ_{purchased} \times SC$	X		
		X	Inventory movement
$AQ_{used} \times SC$	X		
		X	usage variance
$SQ_{used} \times SC$	X		

Where:

AQ = Actual quantity

AC = Actual cost per kg

SC = Standard cost per kg

SQ = Standard quantity needed to make actual production

Example: Alternative method for calculating material variances (Lagos Manufacturing Limited)

Standard material cost per unit: (5kgs × ₦1,000 per kg) = ₦5,000 per unit
Actual production in period = 1,000 units.
Materials purchased and used: 4,850 kgs at a cost of ₦4,608,000

	₦'000	₦'000
AQ $_{purchased}$ × AC		
4,850 kgs × ₦X per kg	4,608	
AQ $_{purchased}$ × SC		242 (F) Price variance
4,850 kgs × ₦1,000 per kg	4,850	
AQ $_{used}$ × SC		nil inventory movement
4,850 kgs × ₦1,000 per kg	4,850	
SQ $_{used}$ × SC		150 (F) Usage variance
5,000 kgs × ₦1,000 per kg	5,000	

SQ = 1,000 units × 5 kgs per unit = 5,000 kgs

Practice question **5**

A unit of Product P123 has a standard cost of 5 litres of Material A at ₦3 per litre.

The standard direct material cost per unit of Product P123 is therefore ₦15. In a particular month, 2,000 units of Product P123 were manufactured.

These used 10,400 litres of Material A, which cost ₦33,600.

Calculate the direct materials price and usage variances using the alternative approach.

3.5 Direct materials: possible causes of variances

When variances occur and they appear to be significant, management should investigate the reason for the variance. If the cause of the variance is something within the control of management, control action should be taken. Some of the possible causes of materials variances are listed below.

Materials price variance: causes

Possible causes of favourable materials price variances include:

- Different suppliers were used and these charged a lower price (favourable price variance) than the usual supplier.
- Materials were purchased in sufficient quantities to obtain a bulk purchase discount (a quantity discount), resulting in a favourable price variance.
- Materials were bought that were of lower quality than standard and so cheaper than expected.

Possible causes of adverse materials price variances include:

- Different suppliers were used and these charged a higher price (adverse price variance) than the usual supplier.
- Suppliers increased their prices by more than expected. (Higher prices might be caused by an unexpected increase in the rate of inflation.)
- There was a severe shortage of the materials, so that prices in the market were much higher than expected.
- Materials were bought that were better quality than standard and more expensive than expected.

Materials usage variance: causes

Possible causes of favourable materials usage variances include:

- Wastage rates were lower than expected.
- Improvements in production methods resulted in more efficient usage of materials (favourable usage variance).

Possible causes of adverse materials usage variances include:

- Wastage rates were higher than expected.
- Poor materials handling resulted in a large amount of breakages (adverse usage variance). Breakages mean that a quantity of materials input to the production process is wasted.
- Materials used were of cheaper quality than standard, with the result that more materials had to be thrown away as waste.

4 DIRECT LABOUR VARIANCES

Section overview

- Direct labour: total cost variance
- Direct labour rate variance
- Direct labour efficiency variance
- Idle time variance
- Alternative calculations
- Idle time variance where idle time is included in standard cost
- Direct labour: possible causes of variances

4.1 Direct labour: total cost variance

The total direct labour cost variance is the difference between the actual labour cost in producing units in the period and the standard labour cost of producing those units.

Illustration: Direct labour – total cost variance

	₦
Standard labour cost of actual production:	
Actual units produced × Standard hrs per unit × Standard rate per hr	X
Actual labour cost of actual production:	
Actual units produced × Actual hours per unit × Actual rate per hour	(X)
	X

The variance is adverse (A) if actual cost is higher than the standard cost, and favourable (F) if actual cost is less than the standard cost.

Example: Direct labour – Total cost variance (Lagos Manufacturing Limited)

Standard labour cost per unit: (4 hrs × ₦500 per hr) = ₦2,000 per unit

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours at a cost of ₦2,121,000

Direct labour total cost variance is calculated as follows:

	₦'000
Standard: 1,000 units should cost (@ ₦2,000 per unit)	2,000
Actual: 1,000 units did cost	(2,121)
Total cost variance	(121) **A**

The direct labour total cost variance can be analysed into a rate variance and an efficiency variance. These are calculated in a similar way to the direct materials price and usage variances.

- ❑ A rate variance measures the difference between the actual wage rate paid per labour hour and the rate that should have been paid (the standard rate of pay).
- ❑ An efficiency variance (or productivity variance) measures the difference between the time taken to make the production output and the time that should have been taken (the standard time).

4.2 Direct labour rate variance

The direct labour rate variance is calculated for the actual number of hours paid for.

The actual labour cost of the actual hours paid for is compared with the standard cost for those hours. The difference is the labour rate variance.

Illustration: Direct labour – rate variance

	₦
Standard labour cost of actual production:	
Actual hours paid for × Standard rate per hour	X
Actual labour cost of actual production	
Actual hours paid for × Actual rate per hour	(X)
	X

Example: Direct labour – rate variance (Lagos Manufacturing Limited)

Standard labour cost per unit: (4 hrs × ₦500 per hour) = ₦2,000 per unit

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours at a cost of ₦2,121,000

Direct labour rate variance is calculated as follows:

	₦'000
Standard: 4,200 hours should cost (@ ₦500 per hour)	2,100
Actual: 4,200 hours did cost	(2,121)
Labour rate variance	(21) **A**

If there are two or more different types or grades of labour, each paid at a different standard rate per hour, a rate variance is calculated separately for each labour grade.

4.3 Direct labour efficiency variance

The direct labour efficiency variance is calculated for the hours used on the units produced.

For the actual number of standard units produced, the actual hours worked is compared with the standard number of hours that should have been worked to produce the actual output. The difference is the efficiency variance, measured in hours. This is converted into a money value at the standard direct labour rate per hour.

Illustration: Direct labour – Efficiency variance

	Hours
Standard labour hours used to make the actual production	X
Actual labour hours used to make the actual production	(X)
Efficiency variance (hours)	X
Standard rate per hour (multiply by)	X
Efficiency variance (₦)	X

Example Direct labour – Efficiency variance (Lagos Manufacturing Limited)

Standard labour cost per unit: (4 hrs × ₦500 per hour) = ₦2,000 per unit

Actual production in period = 1,000 units.
Labour hours paid for: 4,200 hours at a cost of ₦2,121,000

Direct labour efficiency variance is calculated as follows:

	Hours
Standard:	
Making 1,000 units should have used (@ 4 hours per unit)	4,000
Actual: Making 1,000 units did use	(4,200)
Efficiency variance (hours) (A)	(200) **A**
Standard rate per hour	₦500
Efficiency variance (₦) (A)	(₦100,000) **A**

Practice question **6**

Product P234 has a standard direct labour cost per unit of:

0.5 hours × ₦12 per direct labour hour = ₦6 per unit.

During a particular month, 3,000 units of Product P234 were manufactured. These took 1,400 hours to make and the direct labour cost was ₦16,200.

Calculate the total direct labour cost variance, the direct labour rate variance and the direct labour efficiency variance for the month.

4.4 Idle time variance

Idle time was explained in the previous chapter. Part of this explanation is repeated here for your convenience.

Idle time occurs 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. Idle time variance is part of the efficiency variance.

Sometimes idle time might be a feature of a production process for example where there may be bottlenecks in a process that might lead to idle time on a regular basis. In this case the expected idle time might be built into the standard cost.

- If idle time is not built into the standard cost the idle time variance is always adverse.
- If it is built into the standard cost the idle time variance might be favourable or adverse depending on whether the actual idle time is more or less than the standard idle time for that level of production.

Idle time not part of standard cost

As stated above if the idle time is not included in the standard cost, any idle time is unexpected and leads to an adverse variance.

Illustration: Direct labour – idle time variance

	Hours
Actual hours paid for	X(X
Actual hours worked	) X
Idle time (hours)	X
Standard rate per hour (multiply by)	X
Idle time (₦)	

Calculating the idle time variance will affect the calculation of the direct labour efficiency variance. If idle time occurs but is not recorded the idle time variance is part of the direct labour efficiency variance.

Example: Direct labour – idle time variance (Lagos Manufacturing Limited)

Standard labour cost per unit: (4 hours × ₦500 per kg) = ₦2,000 per unit

Actual production in period = 1,000 units.
Labour hours paid for: 4,200 hours at a cost of ₦2,121,000
Labour hours worked: 4,100 hours

Direct labour idle time variance is calculated as follows:

	Hours
Actual hours paid for	4,200
Actual hours worked	(4,100)
Idle time (hours)	(100) **A**
Standard rate per hour (multiply by)	₦500
Idle time (₦)	(₦50,000) **A**

Direct labour efficiency variance is calculated as follows:

	Hours
Standard:	
Making 1,000 units should have used (@ 4 hours per unit)	4,000
Actual: Making 1,000 units did use	(4,100)
Efficiency variance (hours)	(100) **A**
Standard rate per hour	₦500
Efficiency variance (₦)	(₦50,000) **A**

4.5 Alternative calculations

The following shows the line by line approach for labour variances.

Formula: Alternative method for calculating labour variances

$AH_{\text{paid for}} \times AR$	X		
		X	Rate variance
$AH_{\text{paid for}} \times SR$	X		
		X	Idle time variance
$AH_{\text{worked}} \times SR$	X		
		X	Efficiency variance
$SH_{\text{worked}} \times SR$	X		

Where:

AH = Actual hours

AR = Actual rate per hour

SR = Standard rate per hour

SH = Standard hours needed to make actual production

Example: Alternative method for calculating labour variances (Lagos Manufacturing Limited)

Standard labour cost per unit: (4 hours × ₦500 per kg) = ₦2,000 per unit

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours at a cost of ₦2,121,000

Labour hours worked: 4,100 hours

	₦'000	₦'000
$AH_{\text{paid for}} \times AR$		
4,200 hours × ₦X per hour	2,121	
$AH_{\text{paid for}} \times SR$		21 (A) Price variance
4,200 hours × ₦500 per hour	2,100	
$AH_{\text{worked}} \times SR$		50 (A) Idle time
4,100 hours × ₦500 per hour	2,050	
$SH_{\text{worked}} \times SR$		50 (A) Efficiency
4,000 hours × ₦500 per hour	2,000	

SQ = 1,000 units × 4 hours per unit = 4,000 hours

Practice question **7**

Product P234 has a standard direct labour cost per unit of:

0.5 hours × ₦12 per direct labour hour = ₦6 per unit.

During a particular month, 3,000 units of Product P234 were manufactured. These took 1,400 hours to make and the direct labour cost was ₦16,200.

Calculate the direct labour rate variance and the direct labour efficiency variance for the month using the alternative approach.

4.6 Idle time variance where idle time is included in standard cost

Methods of including idle time in standard costs

There are different 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. The standard hours per unit therefore include an allowance for expected idle time.

Example: Idle time in standard (Lagos Manufacturing Limited)

Standard labour rate = ₦500 per hour

A unit of production should take 3.6 hours to produce.

Expected idle time is 10% of total time paid for.

Therefore 3.6 hours is 90% of the time that must be paid for to make 1 unit.

4 hours must be paid for (3.6/90%) to make 1 unit).

Expected idle time is 0.4 hours (10% of 4 hours).

Idle time can be built into the standard as follows:

Method 1		₦
Labour	3.6 hours × ₦500 per hour	1,800
Idle time	0.4 hours × ₦500 per hour	200
		2,000

Method 2		₦
Labour	4 hours × ₦500 per hour	2,000

The two methods will result in the identification of the same overall variance for idle time plus labour efficiency but the split of the number may differ.

Example: Method 1 – idle time variance (Idle time included in standard as a separate element) (Lagos Manufacturing Limited)

Standard labour rate = ₦500 per hour

A unit of production should take 3.6 hours to produce.

Expected idle time is 10% of total time paid for.

Therefore 3.6 hours is 90% of the time that must be paid for to make 1 unit.

4 hours must be paid for (3.6/90%) to make 1 unit).

Expected idle time is 0.4 hours (10% of 4 hours).

Idle time can be built into the standard as follows:

Method 1		₦
Labour	3.6 hours × ₦500 per hour	1,800
Idle time	0.4 hours × ₦500 per hour	200
		2,000

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours at a cost of ₦2,121,000

Labour hours worked: 4,100 hours

Direct labour idle time variance is calculated as follows:

	Hours	
Expected idle time (1,000 units × 0.4 hours per unit)	400	
Actual idle time (4,200 hours – 4,100 hours)	(100)	
Idle time (hours)	300	F
Standard rate per hour (multiply by)	₦500	
Idle time (₦)	₦150,000	F

Direct labour efficiency variance is calculated as follows:

	Hours	
Standard:		
Making 1,000 units should have used (@ 3.6 hours per unit)	3,600	
Actual: Making 1,000 units did use	(4,100)	
Efficiency variance (hours)	(500)	A
Standard rate per hour	₦500	
Efficiency variance (₦)	(₦250,000)	A

Example: Method 2 – idle time variance (Idle time allowed for as a standard amount of idle time in the standard hours per unit for each product) (Lagos Manufacturing Limited)

Standard labour rate = ₦500 per hour

A unit of production should take 3.6 hours to produce.

Expected idle time is 10% of total time paid for.

Therefore 3.6 hours is 90% of the time that must be paid for to make 1 unit.

4 hours must be paid for (3.6/90%) to make 1 unit).

Expected idle time is 0.4 hours (10% of 4 hours).

Idle time can be built into the standard as follows:

Method 2		₦
Labour	4 hours × ₦500 per hour	2,000

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours at a cost of ₦2,121,000

Labour hours worked: 4,100 hours

Direct labour idle time variance is calculated as follows:

	Hours	
Expected idle time (10% of 4,200 hours paid for)	420	
Actual idle time (4,200 hours – 4,100 hours)	(100)	
Idle time (hours)	320	F
Standard rate per hour (multiply by)	₦500	
Idle time (₦)	₦160,000	F

Direct labour efficiency variance is calculated as follows:

	Hours	
Standard: Making 1,000 units should have used (4 hours per unit less10% of the hours paid for = 4,000 – (10% of 4,200))	3,580	
Actual: Making 1,000 units did use	(4,100)	
Efficiency variance (hours)	(520)	A
Standard rate per hour	₦500	
Efficiency variance (₦)	(₦260,000)	A

In summary the idle time variance is part of the efficiency variance. Different methods result in a different split of the idle time variance and efficiency variance but the figures always sum to the same total.

Revisiting the previous examples:

Example: Sum of idle time and efficiency variances (Lagos Manufacturing Limited)

	Idle time variance	Efficiency variance	Total
Idle time not recorded	–	100 (A)	100 (A)
Idle time recorded:			
not part of standard cost	50 (A)	50 (A)	100 (A)
part of standard cost (method 1)	150 (F)	250 (A)	100 (A)
part of standard cost (method 2)	160 (F)	260 (A)	100 (A)

4.7 Direct labour: possible causes of variances

When labour variances appear significant, management should investigate the reason why they occurred, and take control measures where appropriate to improve the situation in the future. Possible causes of labour variances include the following.

Possible causes of favourable labour rate variances include:

- Using direct labour employees who were relatively inexperienced and new to the job (favourable rate variance, because these employees would be paid less than ‘normal’).
- Actual pay increase turning out to be less than expected.

Possible causes of adverse labour rate variances include:

- An increase in pay for employees.
- Working overtime hours paid at a premium above the basic rate.
- Using direct labour employees who were more skilled and experienced than the ‘normal’ and who are paid more than the standard rate per hour (adverse rate variance).

Possible causes of favourable labour efficiency variances include:

- More efficient methods of working.
- Good morale amongst the workforce and good management with the result that the work force is more productive.
- If incentive schemes are introduced to the workforce, this may encourage employees to work more quickly and therefore give rise to a favourable efficiency variance.
- Using employees who are more experienced than ‘standard’, resulting in favourable efficiency variances as they are able to complete their work more quickly than less-experienced colleagues.

Possible causes of adverse labour efficiency variances include:

- Using employees who are less experienced than ‘standard’, resulting in adverse efficiency variances.
- An event causing poor morale.

5 VARIABLE PRODUCTION OVERHEAD VARIANCES

Section overview

- Variable production overhead: total cost variance
- Variable production overhead expenditure variance
- Variable production overhead efficiency variance
- Alternative calculations
- Variable production overheads: possible causes of variances

5.1 Variable production overhead: total cost variance

The total variable production overhead cost variance is the difference between the actual variable production overhead cost in producing units in the period and the standard variable production overhead cost of producing those units.

Illustration: Variable production overhead – total cost variance

	₦
Standard variable production overhead cost of actual production:	
Actual units produced × Standard hrs per unit × Standard rate per hr	X
Actual variable production overhead cost of actual production:	
Actual units produced × Actual hours per unit × Actual rate per hour	(X)
	X

The variance is adverse (A) if actual cost is higher than the standard cost, and favourable (F) if actual cost is less than the standard cost.

Example: Variable production overhead – Total cost variance (Lagos Manufacturing Limited)

Standard variable production overhead cost per unit: (4 hrs × ₦200 per hr) = ₦800 per unit

Actual production in period = 1,000 units.

Variable production overhead = ₦945,000.

Labour hours paid for: 4,200 hours

Direct variable production overhead total cost variance is calculated as follows:

	₦'000
Standard: 1,000 units should cost (@ ₦800 per unit)	800
Actual: 1,000 units did cost	(945)
Total cost variance	(145) **A**

The variable production overhead total cost variance can be analysed into an expenditure variance (spending rate per hour variance) and an efficiency variance.

- The expenditure variance is similar to a materials price variance or a labour rate variance. It is the difference between actual variable overhead spending in the hours worked and what the spending should have been (the standard rate).
- The variable overhead efficiency variance in hours is the same as the labour efficiency variance in hours (excluding any idle time variance), and is calculated in a very similar way. It is the variable overhead cost or benefit from adverse or favourable direct labour efficiency variances.

5.2 Variable production overhead expenditure variance

It is normally assumed that variable production overheads are incurred during hours actively worked, but not during any hours of idle time.

- The variable production overhead expenditure variance is calculated by taking the actual number of hours worked.
- The actual variable production overhead cost of the actual hours worked is compared with the standard cost for those hours. The difference is the variable production overhead expenditure variance.

A variable production overhead expenditure variance is calculated as follows. Like the direct labour rate variance, it is calculated by taking the actual number of labour hours worked, since it is assumed that variable overhead expenditure varies with hours worked.

Illustration: Variable production overhead expenditure variance

	₦
Standard variable production overhead cost of actual production:	
Actual hours worked × Standard rate per hour	X
Actual variable production overhead cost of actual purchases	
Actual hours worked × Actual rate per hour	(X)
	X

Example: Variable production overhead expenditure variance (Lagos Manufacturing Limited)

Standard variable production overhead cost per unit: (4 hrs × ₦200 per hr) = ₦800 per unit

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours

Labour hours worked: 4,100 hours at a variable overhead cost of ₦945,000.

Variable production overhead rate variance is calculated as follows:

	₦'000
Standard: 4,100 hours should cost (@ ₦200 per hour)	820
Actual: 4,100 hours did cost	(945)
Variable production overhead rate variance	(125) **A**

5.3 Variable production overhead efficiency variance

The variable production overhead efficiency variance in hours is exactly the same as the direct labour efficiency variance in hours.

It is converted into a money value at the standard variable production overhead rate per hour.

Illustration: Variable production overhead – Efficiency variance

	Hours
Standard hours used to make the actual production	X
Actual hours used to make the actual production	(X)
Efficiency variance (hours)	X
Standard rate per hour (multiply by)	X
Efficiency variance (₦)	X

Example Variable production overhead efficiency variance (Lagos Manufacturing Limited)

Standard variable production overhead cost per unit: (4 hrs × ₦200 per kg) = ₦800 per unit

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours

Labour hours worked: 4,100 hours at a variable overhead cost of ₦945,000.

Variable production overhead efficiency variance is calculated as follows:

	Hours
Standard:	
Making 1,000 units should have used (@ 4 hours per unit)	4,000
Actual: Making 1,000 units did use	(4,100)
Efficiency variance (hours)	(100) **A**
Standard rate per hour	₦200
Efficiency variance (₦)	(₦20,000) **A**

Practice question **8**

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 P123 were manufactured. These took 2,780 hours to make and the variable production overhead cost was ₦6,550.

Calculate the total variable production overhead cost variance, the variable production overhead expenditure variance and the variable production overhead efficiency variance for the month.

5.4 Alternative calculations

The following shows the line by line approach for variable production overhead variances.

Formula: Alternative method for calculating variable production overhead variances

$AH_{worked} \times AR$	X		
		X	Rate variance
$AH_{worked} \times SR$	X		
		X	Efficiency variance
$SH_{worked} \times SR$	X		

Where:

AH = Actual hours

AR = Actual rate per hour

SR = Standard rate per hour

SH = Standard hours needed to make actual production

Example: Alternative method for calculating variable production overhead variances (Lagos Manufacturing Limited)

Standard variable production overhead cost per unit: (4 hrs × ₦200 per kg) = ₦800 per unit

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours

Labour hours worked: 4,100 hours at a variable overhead cost of ₦945,000.

	₦'000	₦'000
$AH_{worked} \times AR$		
4,100 hours × ₦X per hour	945	
$AH_{worked} \times SR$		125 (A) Expenditure
4,100 hours × ₦200 per hour	820	
$SH_{worked} \times SR$		20 (A) Efficiency
4,000 hours × ₦200 per hour	800	

SH = 1,000 units × 4 hours per unit = 4,000 hours

Practice question **9**

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 P123 were manufactured. These took 2,780 hours to make and the variable production overhead cost was ₦6,550.

Calculate the variable production overhead expenditure variance and the variable production overhead efficiency variance for the month using the alternative approach.

5.5 Variable production overhead: possible causes of variances

Possible causes of favourable variable production overhead expenditure variances include:

- ❑ Forecast increase in costs not materialising

Possible causes of adverse variable production overhead variances include:

- ❑ Unexpected increases in energy prices

Anything that causes labour efficiency variance will have an impact on variable production overhead efficiency variances as variable production overhead is incurred as the labour force carries out production.

Possible causes of favourable variable production overhead efficiency variances include:

- ❑ More efficient methods of working.
- ❑ Good morale amongst the workforce and good management with the result that the work force is more productive.
- ❑ If incentive schemes are introduced to the workforce, this may encourage employees to work more quickly and therefore give rise to a favourable efficiency variance.
- ❑ Using employees who are more experienced than 'standard', resulting in favourable efficiency variances as they are able to complete their work more quickly than less-experienced colleagues.

Possible causes of adverse variable production overhead efficiency variances include:

- ❑ Using employees who are less experienced than 'standard', resulting in adverse efficiency variances.
- ❑ An event causing poor morale.

6 FIXED PRODUCTION OVERHEAD COST VARIANCES: ABSORPTION COSTING

Section overview

- Over/under absorption
- Total fixed production overhead cost variance
- Fixed production overhead expenditure variance
- Fixed production overhead volume variance
- Fixed production overhead efficiency and capacity variances
- Fixed production overheads: possible causes of variances

6.1 Over/under absorption

Variances for fixed production overheads are different from variances for variable costs.

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. 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.

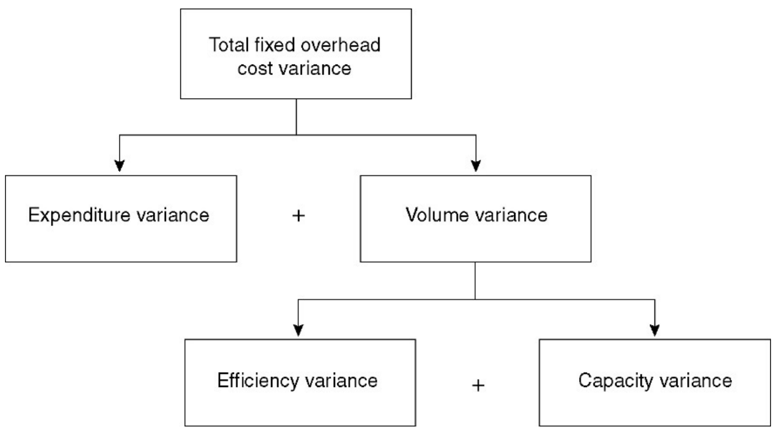
The total fixed overhead cost variance is the total amount of under-absorbed or over-absorbed overheads, where overheads are absorbed at the standard fixed overhead cost per unit.

It was explained in an earlier chapter that the total under- or over-absorption of fixed overheads can be analysed into an expenditure variance and a volume variance.

The total volume variance can be analysed even further in standard absorption costing, into a fixed overhead capacity variance and a fixed overhead efficiency variance.

Fixed overhead variances are as follows:

Illustration: Analysis of fixed production overhead variances



6.2 Total fixed production overhead cost variance

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).

Overheads are absorbed at a standard fixed cost per unit produced, not at standard rate per hour.

Illustration: Fixed production overhead – total cost variance (over/under absorption)

	₦
Fixed production overhead absorbed in the period:	
Actual units produced × Fixed production overhead per unit	X
Actual fixed production overhead incurred in the period	(X)
Total fixed production overhead variance (Over/(under) absorption)	X

The total fixed production overhead cost variance can be analysed into an expenditure variance and a volume variance. Together, these variances explain the reasons for the under- or over-absorption.

Example: Fixed production overhead – total cost variance (over/under absorption) (Lagos Manufacturing Limited)

Budgeted fixed production overhead	₦2,880,000
Budgeted production hours: = Budgeted production volume × Standard hours per unit = 1,200 units × 4 hours per unit	4,800 hours
Overhead absorption rate ₦2,880,000/4,800 hours	₦600 per hour
Standard fixed production overhead per unit = 4 hours × ₦600 per hour	₦2,400 per unit
Actual fixed production overhead	₦2,500,000
Actual production	1,000 units

The total cost variance for fixed production overhead (over/under absorption) is calculated as follows:

	₦'000
Fixed production overhead absorbed in the period: = Actual units produced × Fixed production overhead per unit = 1,000 units × ₦2,400 per unit	2,400
Actual fixed production overhead incurred in the period	(2,500)
Under absorption	(100) **A**

The amount of fixed production overhead absorption rate is a function of the budgeted fixed production overhead expenditure and the budgeted production volume.

The total variance can be explained in these terms.

6.3 Fixed production overhead expenditure variance

A fixed production overhead expenditure variance is very easy to calculate. It is simply the difference between the budgeted fixed production overhead expenditure and actual fixed production overhead expenditure.

Illustration: Fixed production overhead – expenditure variance

	₦
Budgeted fixed production overhead	X
Actual fixed production overhead incurred	(X)
Fixed production overhead expenditure variance	X

An adverse expenditure variance occurs when actual fixed overhead expenditure exceeds the budgeted fixed overhead expenditure.

A favourable expenditure variance occurs when actual fixed overhead expenditure is less than budget.

Example: Fixed production overhead – expenditure variance (Lagos Manufacturing Limited)

	₦'000
Budgeted fixed production overhead	2,880
Actual fixed production overhead	(2,500)
Fixed production overhead expenditure variance	380 **F**

Fixed overhead expenditure variances can be calculated, for control reporting, for other overheads as well as production overheads. For example:

- an administration fixed overheads expenditure variance is the difference between budgeted and actual fixed administration overhead costs
- a sales and distribution fixed overhead expenditure variance is the difference between budgeted and actual fixed sales and distribution overhead costs

6.4 Fixed production overhead volume variance

The fixed production overhead volume variance measures the amount of fixed overheads under- or over-absorbed because of the fact that actual production volume differs from the budgeted production volume.

The volume variance is measured first of all in either units of output or standard hours of the output units.

The volume variance in units (or standard hours of those units) is converted into a money value, as appropriate, at the standard fixed overhead cost per unit (or the standard fixed overhead rate per standard hour produced).

Illustration: Fixed production overhead – volume variance

	Units
Actual number of units produced	X(X
Budgeted production	) X
Fixed production overhead volume variance (units)	X
Standard absorption rate per unit	X
Fixed production overhead volume variance (₦)	

Example Fixed production overhead – volume variance (Lagos Manufacturing Limited)

Budgeted fixed production overhead	₦2,880,000
Budgeted production hours: = Budgeted production volume × Standard hours per unit = 1,200 units × 4 hours per unit	4,800 hours
Overhead absorption rate ₦2,880,000/4,800 hours	₦600 per hour
Standard fixed production overhead per unit = 4 hours × ₦600 per hour	₦2,400 per unit
Actual fixed production overhead	₦2,500,000
Actual production	1,000 units

The volume variance is calculated as follows:

	Units
Actual number of units produced	1,000
Budgeted production	(1,200)
Fixed production overhead volume variance (units)	(200) **A**
Fixed production overhead per unit	₦2,400
Fixed production overhead volume variance (₦)	₦480,000 **A**

Practice questions **10**

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.

Calculate the total fixed production overhead cost variance, the fixed overhead expenditure variance and the fixed overhead volume variance for the year.

6.5 Fixed production overhead efficiency and capacity variances

Any volume variance might be due to two reasons:

- The company has worked a different number of hours than budgeted. They have operated at a different capacity.
- During the hours worked the company has operated at a different level of efficiency to that budgeted.

The fixed production overhead volume variance can be analysed into a fixed overhead efficiency variance and a fixed overhead capacity variance.

Fixed production overhead efficiency variance

This is exactly the same, in hours, as the direct labour efficiency variance and the variable production overhead efficiency variance.

It is converted into a money value at the standard fixed overhead rate per hour.

Illustration: Fixed production overhead – Efficiency variance

	Hours
Standard hours used to make the actual production	X
Actual hours used to make the actual production	(X)
Efficiency variance (hours)	X
Standard rate per hour (multiply by)	X
Efficiency variance (₦)	X

Example: Fixed production overhead efficiency variance (Lagos Manufacturing Limited)

Standard fixed production overhead cost per unit: (4 hrs × ₦600 per hr) = ₦2,400 per unit

Actual production in period = 1,000 units.

Labour hours paid for: 4,200 hours

Labour hours worked: 4,100

Fixed production overhead efficiency variance is calculated as follows:

	Hours
Standard: Making 1,000 units should have used (@ 4 hours per unit)	4,000
Actual: Making 1,000 units did use	(4,100)
Efficiency variance (hours)	(100) **A**
Standard rate per hour	₦600
Efficiency variance (₦)	(₦60,000) **A**

Fixed production overhead capacity variance

This is the difference between the budgeted and actual hours worked (excluding any idle time hours). It is converted into a money value at the standard fixed overhead rate per hour.

Illustration: Fixed production overhead – Capacity variance

	Hours
Actual number of hours worked	X
Budgeted hours to be worked	(X)
Capacity variance (hours)	X
Standard rate per hour (multiply by)	X
Capacity variance (₦)	X

Example: Fixed production overhead capacity variance (Lagos Manufacturing Limited)

Budgeted fixed production overhead	₦2,880,000
Budgeted production hours: = Budgeted production volume × Standard hours per unit = 1,200 units × 4 hours per unit	4,800 hours
Overhead absorption rate ₦2,880,000/4,800 hours	₦600 per hour
Standard fixed production overhead per unit = 4 hours × ₦600 per hour	₦2,400 per unit
Actual fixed production overhead	₦2,500,000
Actual production	1,000 units

The fixed production overhead capacity variance is calculated as follows:

	Hours
Actual number of hours worked	4,100
Budgeted hours to be worked	(4,800)
Capacity variance (hours)	(700) **A**
Standard rate per hour (multiply by)	₦600
Capacity variance y variance (₦)	(₦420,000) **A**

Practice questions **11**

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.

Calculate the fixed overhead efficiency variance and the fixed overhead capacity variance for the year.

6.6 Fixed production overheads: possible causes of variances

Some of the possible causes of fixed production overhead variances include the following.

Fixed overhead expenditure variance

- Poor control over overhead spending (adverse variance) or good control over spending (favourable variance).
- Poor budgeting for overhead spending. If the budget for overhead expenditure is unrealistic, there will be an expenditure variance due to poor planning rather than poor expenditure control.
- Unplanned increases or decreases in items of expenditure for fixed production overheads, for example, an unexpected increase in factory rent.

Fixed overhead volume variance

A fixed overhead volume variance can be explained by anything that made actual output volume different from the budgeted volume. The reasons could be:

- Efficient working by direct labour: a favourable labour efficiency variance results in a favourable fixed overhead efficiency variance.
- Working more hours or less hours than budgeted (capacity variance).
- An unexpected increase or decrease in demand for a product, with the result that longer hours were worked (adverse capacity variance).
- Strike action by the workforce, resulting in a fall in output below budgeted output (adverse capacity variance).
- Extensive breakdowns in machinery, resulting in lost production (adverse capacity variance).

7 SALES VARIANCES

Section overview

- Sales variances: Introduction
- Sales price variance
- Sales volume variance
- Sales: possible causes of variances

7.1 Sales variances: Introduction

Sales variances, unlike cost variances, are not recorded in a standard costing system of cost accounts (in the cost ledger). However, sales variances are included in variance reports to management.

They help to reconcile actual profit with budgeted profit.

They help management to assess the sales performance.

There are two sales variances:

- a sales price variance; and
- a sales volume variance

7.2 Sales price variance

A sales price variance shows the difference between:

- the actual sales prices achieved for items that were sold, and
- their standard sales price

To calculate this variance, you should take the **actual items sold**, and compare the actual sales revenue with the standard selling prices for the items. This compares the revenue actually generated to the revenue that should have been generated if the items were sold at the standard selling price per unit.

Illustration: Sales price variance

	₦
Standard revenue for actual sales	
Actual sales × Standard selling price per unit	X
Actual revenue	
Actual sales × Actual selling price per unit	(X)
	X

There is a favourable sales price variance if units were sold for more than their standard sales price, and an adverse variance if sales prices were below the standard price.

Example: Sales price variance (Lagos Manufacturing Limited)

Budgeted sales volume	1,000 units
Budgeted selling price per unit	₦15,000
Actual sales volume	900 units
Actual revenue	₦12,600,000

Sales price variance is calculated as follows:

	₦'000
Standard revenue for actual sales	
900 units × ₦15,000 per unit	13,500
Actual revenue	
Actual sales × Actual selling price per unit	(12,600)
Sales price variance	900 **A**

7.3 Sales volume variance

A sales volume variance shows the effect on profit of the difference between the actual sales volume and the budgeted sales volume.

In a **standard absorption costing system**, the sales volume variance might be called a sales volume **profit** variance.

The variance is calculated by comparing the actual number of units sold (actual sales volume) to the number of units expected to be sold when the original budget was drafted (budgeted sales volume).

This is then expressed as a money value by multiplying it by the standard profit per unit.

Illustration: Sales volume variance

	Units
Budgeted sales volume	X
Actual sales volume	(X)
Sales volume variance (units)	X
Standard profit per unit (multiply by)	X
Sales volume variance (₦)	X

Example: Sales volume variance (Lagos Manufacturing Limited)

Budgeted sales volume	1,000 units
Budgeted selling price per unit	₦15,000
Standard cost per unit (from the standard cost card)	₦10,200
Therefore, standard profit per unit	₦4,800
Actual sales volume	900 units
Actual revenue	₦12,600,000

Sales volume variance is calculated as follows:

	Units
Budgeted sales volume	1,000
Actual sales volume	900
Sales volume variance (units)	(100) **A**
Standard profit per unit (multiply by)	₦4,800
Sales volume variance	(₦480,000) **A**

The volume variance is favourable if actual sales volume is higher than the budgeted volume and adverse if the actual sales volume is below budget.

There is an alternative method of calculating the sales volume variance, which produces exactly the same figure for the variance.

Practice question **12**

A company budgets to sell 7,000 units of Product P456. It uses a standard absorption costing system. 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.

Calculate the sales price variance and sales volume variance.

7.4 Sales: possible causes of variances

Possible causes of sales variances include the following:

Sales price variance

- Actual increases in prices charged for products were higher or less than expected due to market conditions.
- Actual sales prices were less than standard because major customers were given an unplanned price discount.
- Competitors reduced their prices, forcing the company to reduce the prices of its own products.

Sales volume variance

- ❑ Actual sales demand was more or less than expected.
- ❑ The sales force worked well and achieved more sales than budgeted.
- ❑ An advertising campaign had more success than expected.
- ❑ A competitor went into liquidation, and the company attracted some of the former competitor's customers.
- ❑ The products that the company makes and sells are going out of fashion earlier than expected; therefore the sales volume variance was adverse.

8 INTERRELATIONSHIPS BETWEEN VARIANCES

Section overview

- The nature of interrelationships between variances
- Sales price and sales volume
- Materials price and usage
- Labour rate and efficiency
- Labour rate and variable overhead efficiency
- Capacity and efficiency
- Footnote: the importance of reliable standard costs

8.1 The nature of interrelationships between variances

Some causes of individual variances have already been listed.

The reasons for variances might also be connected, and two or more variances might arise from the same cause. This is known as an interrelationship between two variances.

For example, one variance might be favourable and another variance might be adverse. Taking each variance separately, the favourable variance might suggest good performance and the adverse variance might suggest bad performance. However, the two variances might be inter-related, and the favourable variance and the adverse variance might have the same cause. When this happens, management should look at the two variances together, in order to assess their significance and decide whether control action is needed.

Examples of interrelationships between variances are given below.

8.2 Sales price and sales volume

A favourable sales price variance and an adverse sales volume variance might have the same cause. If a company increases its selling prices above the standard price, the sales price variance will be favourable, but sales demand might fall and the sales volume variance would be adverse.

Similarly, in order to sell more products a company might decide to reduce its selling prices. There would be an adverse sales price variance due to the reduction in selling prices, but there should also be an increase in sales and a favourable sales volume variance.

8.3 Materials price and usage

A materials price variance and usage variance might be inter-related. For example, if a company decides to use a material for production that is more expensive than the normal or standard material, but easier to use and better in quality, there will be an adverse price variance. However a consequence of using better materials might be lower wastage. If there is less wastage, there will be a favourable material usage variance. Therefore, using a different quality of material can result in an adverse price variance and a favourable usage variance.

8.4 Labour rate and efficiency

If there is a change in the grade of workers used to do some work, both the rate and efficiency variances may be affected.

For example, if a lower grade of labour is used instead of the normal higher grade:

- ❑ there should be a favourable rate variance because the workers will be paid less than the standard rate
- ❑ however the lower grade of labour may work less efficiently and take longer to produce goods than the normal higher grade of labour would usually take. If the lower grade of labour takes longer, then this will give rise to an adverse efficiency variance.

Therefore the change in the grade of labour used results in two 'opposite' variances, an adverse efficiency variance and a favourable rate variance.

When inexperienced employees are used, they might also waste more materials than more experienced employees would, due to mistakes that they make in their work. The result might be not only adverse labour efficiency, but also adverse materials usage.

8.5 Labour rate and variable overhead efficiency

When a production process operates at a different level of efficiency the true cost of that difference is the sum of any costs associated with labour hours. Therefore, the issues described above also affect the variable overhead efficiency variance.

8.6 Capacity and efficiency

If a production process operates at a higher level of efficiency that might mean that it does not have to operate for as long to produce the budgeted production volume. The favourable fixed production overhead efficiency variance would cause an adverse fixed production overhead capacity variance.

The reverse is also true. If a production process operates at a lower level of efficiency that might mean that it has to operate for longer than was budgeted. The adverse efficiency fixed production overhead variance would cause a favourable fixed production overhead capacity variance.

8.7 Footnote: the importance of reliable standard costs

It is important to remember that the value of variances as control information for management depends on the reliability and accuracy of the standard costs. If the standard costs are inaccurate, comparisons between actual cost and standard cost will have no meaning. Adverse or favourable variances might be caused by inaccurate standard costs rather than by inefficient or efficient working.

9 RECONCILING BUDGETED AND ACTUAL PROFIT: STANDARD ABSORPTION COSTING

Section overview

- Purpose of an operating statement
- Format of an operating statement

9.1 Purpose of an operating statement

A management report called an operating statement might be prepared, showing how the difference between budgeted and actual profit is explained by the sales variances and cost variances. An operating statement reconciles the profit that was expected in the budget with the actual profit that was achieved.

The purpose of an operating statement is to report all variances to management, so that management can assess the effect they are having on profitability. Senior management can also use an operating statement to assess the success of junior managers in controlling costs and achieving sales.

9.2 Format of an operating statement

In a standard absorption costing system, an operating statement can be set out as follows.

This is best demonstrated with an example. The variances calculated for Lagos Manufacturing Limited will be used.

Example: Operating statement for Lagos Manufacturing Limited (standard total absorption costing)

	₦'000	₦'000	₦'000	
Budgeted profit			4,800	
Sales price variance			(900)	(A)
Sales volume variance			(480)	(A)
			3,420	
Cost variances	(F)	(A)		
Direct materials price	242			
Direct materials usage	150			
Direct labour rate		21		
Direct labour efficiency		50		
Direct labour idle time		50		
Variable production o'head expenditure		125		
Variable production o'head efficiency		20		
Fixed production overhead expenditure	380			
Fixed production overhead efficiency		60		
Fixed production overhead capacity		420		
Total cost variances	772	746	26	F
Actual profit			3,446	

Note: 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.

In a system of absorption costing:

- ❑ The operating statement begins with the budgeted profit.
- ❑ The sales variances are shown next. These are added to (favourable variances) or subtracted from (adverse variances), and the resulting figure is shown as a sub-total. This figure is the actual sales revenue in the period minus the standard production cost of sales.
- ❑ The cost variances are listed next. They can be listed in any format, but showing separate columns for favourable variances and adverse variances helps to make the statement clear to the reader. Adverse variances reduce the profit and favourable variances add to profit.
- ❑ The cost variances are added up and then shown as a total.
- ❑ The actual profit is shown as the final figure, at the bottom of the operating statement.

10 STANDARD MARGINAL COSTING

Section overview

- ■ Standard marginal costing
- ■ Standard marginal costing variances
- ■ Standard marginal costing operating statement

10.1 Standard marginal costing

The Lagos Manufacturing Limited example used in the earlier sections was based on the company using standard total absorption costing.

This sections looks at what happens when a company uses standard marginal costing instead.

Under marginal costing units produced and finished goods inventory are valued at standard variable production cost, not standard full production cost. This means that the budgeted profit will differ from that found for the same scenario under total absorption costing.

Marginal costing variances are calculated exactly as before with two important differences:

- ❑ the sales volume variance is expressed as a monetary amount by multiplying the volume variance expressed in units by the standard contribution per unit rather than the standard profit per unit; and
- ❑ there is no fixed overhead volume variance.

The Lagos Manufacturing Limited example will be used to illustrate the approach.

Example: Standard cost card (Lagos Manufacturing Limited)

		₦
Direct materials	5 kg @ ₦1,000 per kg	5,000
Direct labour	4 hours @ ₦500 per hour	2,000
Variable overhead	4 hours @ ₦200 per hour	800
Marginal production cost		7,800

Fixed budget

Here is the flexed budget to show the detailed calculation of the budgeted profit.

Example: Flexed budget for a period

Lagos Manufacturing Limited has budgeted to make 1,200 units and sell 1,000 units in January.

The selling price per unit is budgeted at ₦15,000.

The standard costs of production are as given in the previous example.

The budget prepared for January is as follows:

Unit sales	1,000
Unit production	1,200

Budget		₦'000
Sales	(1,000 units × 15,000)	15,000
Cost of sales:		
Materials	(1,200 units ×₦5,000 per unit)	6,000
Labour	(1,200 units × ₦2,000 per unit)	2,400
Variable overhead	(1,200 units × ₦800 per unit)	960
		9,360
Closing inventory	(200 units × ₦7,800 per unit)	(1,560)
Cost of sales	(1,000 units × ₦7,800 per unit)	(7,800)
		7,200
Fixed overhead		(2,880)
Profit		4,320

This figure could have been calculated more easily as follows:

Example: Fixed budget for a period

	₦'000
Budgeted contribution (1,000 units × (₦15,000 – ₦7,800)	7,200
Less: Budgeted fixed production overhead	(2,880)
Profit	4,320

Flexed budget

Here are profit statements redrafted to marginal cost basis.

Example: Fixed budget, flexed budget and actual results for a period. (Lagos Manufacturing Limited)

	Fixed budget	Flexed budget	Actual
Unit sales	1,000	900	900
Unit production	1,200	1,000	1,000

	Budget	Actual	Actual
Budget	₦'000	₦'000	₦'000
Sales	15,000	13,500	12,600
Cost of sales:			
Materials	6,000	5,000	4,608
Labour	2,400	2,000	2,121
Variable overhead	960	800	945
	9,360	7,800	7,674
Closing inventory	(1,560)	(780)	(780)
Cost of sales	(10,200)	(7,020)	(6,894)
		6,480	5,706
Fixed overhead	(2,880)	(2,400)	(2,500)
Profit	4,800	4,080	3,206

Note:

The actual closing inventory of 100 units is measured at the standard marginal production cost of ₦7,800 per unit. This is what happens in standard costing systems.

10.2 Standard marginal costing variances

Identical variances

All variable cost variances are the same under standard total absorption costing and standard marginal costing.

Sales price variance is the same under standard total absorption costing and standard marginal costing.

Fixed overhead variances

Only the fixed production overhead expenditure variance is relevant and this is calculated in the same way as seen previously.

There is no fixed production overhead volume variance

Sales volume variance

The sales volume variance shows the effect on contribution of the difference between the actual sales volume and the budgeted sales volume.

The variance is calculated by comparing the actual number of units sold (actual sales volume) to the number of units expected to be sold when the original budget was drafted (budgeted sales volume).

This is then expressed as a money value by multiplying it by the standard contribution per unit.

Illustration: Sales volume variance (marginal costing)

	Units
Budgeted sales volume	X
Actual sales volume	(X)
Sales volume variance (units)	X
Standard contribution per unit (multiply by)	₦X
Sales volume variance	₦X

Example: Sales volume variance (Lagos Manufacturing Limited)

Budgeted sales volume	1,000 units
Budgeted selling price per unit	₦15,000
Standard cost per unit (from the standard cost card)	₦7,800
Therefore, standard contribution per unit	₦7,200

Sales volume variance is calculated as follows:

	Units
Budgeted sales volume	1,000
Actual sales volume	900
Sales volume variance (units)	100 **A**
Standard contribution per unit (multiply by)	₦7,200
Sales volume variance	₦720,000 **A**

10.3 Standard marginal costing operating statement

With standard marginal costing, an operating statement is presented in a different way from an operating statement with standard absorption costing.

Budgeted contribution is reconciled with actual contribution, by means of the sales price variance, sales volume variance and variable cost variances.

Fixed cost expenditure variances are presented in a separate part of the operating statement.

Example: Operating statement for Lagos Manufacturing Limited (standard marginal costing)

	₦'000	₦'000	₦'000	
Budgeted contibution			7,200	
Sales price variance			(900)	(A)
Sales volume variance			(720)	(A)
			5,580	
Cost variances	(F)	(A)		
Direct materials price	242			
Direct materials usage	150			
Direct labour rate		21		
Direct labour efficiency		50		
Direct labour idle time		50		
Variable production o'head expenditure		125		
Variable production o'head efficiency		20		
Total cost variances	392	266	126	F
			5,706	
Budgeted fixed production overhead		2,880		
Fixed production overhead expenditure variance		(380) **F**		
Less: Actual fixed production overheads			(2,500)	
Actual profit			3,206	

11 PRODUCTIVITY, EFFICIENCY AND CAPACITY RATIOS

Section overview

- Resource utilisation
- Efficiency ratio
- Capacity utilisation ratio
- Production volume ratio (activity ratio)
- Summary of example
- Link to variance analysis

11.1 Resource utilisation

Resource utilisation is about how effectively resources have been used to generate output. It is also described as productivity.

Performance measures are based on comparisons of the actual hours used to make the actual production, the number of hours that were expected to be used to make the actual production and the total number of hours that were expected to be used in the period.

Three ratios are used to provide information on resource utilisation. These ratios are related to the fixed overhead variances which were explained earlier.

The three ratios are:

- **Efficiency ratio:** This is concerned with how well the actual hours worked have been used to generate output.
- **Capacity ratio:** This is concerned with how many hours were worked compared to the hours that should have been worked.
- **Production volume ratio:** This is a function of the other two ratios. Differences between efficiency of the hours worked compared to budgeted efficiency and the number of the hours worked compared to the budgeted hours, result in volume of output being different to that budgeted.

Link between the ratios

The three ratios are linked as follows:

Formula: Relationship between the three ratios

Efficiency ratio $\times$ Capacity ratio = Production volume ratio

11.2 Efficiency ratio)

Formula: Efficiency ratio

$$\text{Efficiency ratio} = \frac{\text{Expected hours to produce the actual output}}{\text{Actual hours to produce the actual output}} \times 100$$

or (stated in terms of standard hours):

$$\text{Efficiency ratio} = \frac{\text{Standard hours to produce the actual output}}{\text{Actual hours to produce the actual output}} \times 100$$

Example: Efficiency ratio

During July, a factory planned to make 4,000 units of a product. The expected production time is 3 direct labour hours for each unit.

The factory actually produced 3,600 units of the product.

The actual number of direct labour hours worked in the month was 10,000 hours.

Therefore:

	Hours
Actual hours to make actual production	10,000
Expected time to make the actual production (3,600 units should have used 3 hours per unit)	10,800
Total number of hours expected to be used (4,000 units should have used 3 hours per unit)	12,000

The efficiency ratio is calculated as follows:

$$\text{Efficiency ratio} = \frac{10{,}800 \text{ hours}}{10{,}000 \text{ hours}} \times 100 = 108\%$$

The efficiency ratio expresses the number of hours that the actual production should have taken (according to the budget) as a percentage of the actual number of hours taken.

- When output is produced in exactly the time expected, the efficiency ratio is 100%.
- The efficiency ratio is above 100% when output is produced more quickly (i.e. taking fewer hours) than expected.
- The efficiency ratio is below 100% when output is produced more slowly (i.e. taking more hours) than expected.

Efficiency ratio and idle time

Employees are not always engaged in active work during the time they attend the work place. Employees might be ‘idle’ for several reasons, such as waiting for the next work to come along, or because of a halt in production due to a machine breakdown.

When a labour efficiency ratio is calculated, the actual hours worked should **exclude** any hours recorded as idle time.

11.3 Capacity utilisation ratio

The capacity utilisation ratio measures the actual hours actively working as a percentage of the total hours available for work.

The total number of hours available for work is known as capacity. Capacity might be expressed in terms of the budgeted hours or the actual hours that were available for working. (It is usually expressed as the budgeted number of hours).

Capacity ratio

Formula: Capacity ratio

$$\text{Capacity ratio} = \frac{\text{Actual hours worked}}{\text{Total hours available for work}} \times 100$$

Example: Capacity ratio

During July, a factory planned to make 4,000 units of a product. The expected production time is 3 direct labour hours for each unit.

The factory actually produced 3,600 units of the product.

The actual number of direct labour hours worked in the month was 10,000 hours.

Therefore:

	Hours
Actual hours to make actual production	10,000
Expected time to make the actual production (3,600 units should have used 3 hours per unit)	10,800
Total number of hours expected to be used (4,000 units should have used 3 hours per unit)	12,000

The capacity ratio is calculated as follows:

$$\text{Capacity ratio} = \frac{10{,}000 \text{ hours}}{12{,}000 \text{ hours}} \times 100 = 83.33\%$$

Capacity expressed as actual hours

The information provided allows the calculation of capacity as the actual hours that should have been might worked in the week. For example, if a factory had 10 workers, who worked 8 hours per day for 6 days a week, the capacity would be 10 employees $\times$ 8 hours $\times$ 6 days = 480 hours).

Example: Capacity ratio

A production department has 6 employees who each work 40 hours a week. In a particular week, the recorded idle time was 25 hours.

Total hours available for work = 6 employees × 40 hours = 240 hours.

The capacity ratio is calculated as follows:

$$\text{Capacity ratio} = \frac{(240 - 25) = 215 \text{ hours}}{240 \text{ hours}} \times 100 = 89.63\%$$

11.4 Production volume ratio (activity ratio)

Labour activity can also be measured by a production volume ratio which is calculated as follows:

Production volume ratio

Formula: Production volume ratio

$$\text{Volume ratio} = \frac{\text{Expected hours to produce the actual output}}{\text{Total hours available for work}} \times 100$$

Example: Production volume ratio

During July, a factory planned to make 4,000 units of a product. The expected production time is 3 direct labour hours for each unit.

The factory actually produced 3,600 units of the product.

The actual number of direct labour hours worked in the month was 10,000 hours.

Therefore:

	Hours
Actual hours to make actual production	10,000
Expected time to make the actual production (3,600 units should have used 3 hours per unit)	10,800
Total number of hours expected to be used (4,000 units should have used 3 hours per unit)	12,000

The production volume ratio is calculated as follows:

$$\text{Production volume ratio} = \frac{10{,}800 \text{ hours}}{12{,}000 \text{ hours}} \times 100 = 90\%$$

11.5 Summary of example

Example: Efficiency ratio

During July, a factory planned to make 4,000 units of a product. The expected production time is 3 direct labour hours for each unit.

The factory actually produced 3,600 units of the product.

The actual number of direct labour hours worked in the month was 10,000 hours.

Therefore:

	Hours
Actual hours to make actual production	10,000
Expected time to make the actual production (3,600 units should have used 3 hours per unit)	10,800
Total number of hours expected to be used (4,000 units should have used 3 hours per unit)	12,000

The three ratios are calculated as follows:

$$\text{Efficiency ratio} = \frac{10{,}800 \text{ hours}}{10{,}000 \text{ hours}} \times 100 = 108\%$$

$$\text{Capacity ratio} = \frac{10{,}000 \text{ hours}}{12{,}000 \text{ hours}} \times 100 = 83.33\%$$

$$\text{Production volume ratio} = \frac{10{,}800 \text{ hours}}{12{,}000 \text{ hours}} \times 100 = 90$$

Using the answers obtained above:

Labour efficiency ratio	108%
Capacity utilisation ratio	× 83.33%
Production volume ratio	90%

11.6 Link to variance analysis

The ratios discussed in this section offer another way of looking at the information which underpins the calculation of the fixed production overhead variances.

Example: Efficiency ratio

Returning to the variance analysis example that runs through this chapter:

	Hours
Actual hours to make actual production	4,100
Expected time to make the actual production (1,000 units should have used 4 hours per unit)	4,000
Total number of hours expected to be used (1,200 units should have used 4 hours per unit)	4,800

The three ratios are calculated as follows:

$$\text{Efficiency ratio} = \frac{4{,}000 \text{ hours}}{4{,}100 \text{ hours}} \times 100 = 97.56\%$$

$$\text{Capacity ratio} = \frac{4{,}100 \text{ hours}}{4{,}800 \text{ hours}} \times 100 = 85.42\%$$

$$\text{Production volume ratio} = \frac{4{,}000 \text{ hours}}{4{,}800 \text{ hours}} \times 100 = 83.33\%$$

Using the answers obtained above:

Labour efficiency ratio	97.56%
Capacity utilisation ratio	× 85.42%
Production volume ratio	83.33%

Practice question **13**

A business planned to make 1,200 units at a standard time of 2 hours per unit.

Actual production was 1,100 units.

The actual time taken was 2,250 hours.

Therefore:

	Hours
Actual hours to make actual production	2,250
Expected time to make the actual production (1,100 units should have used 2 hours per unit)	2,200
Total number of hours expected to be used (1,200 units should have used 1 hours per unit)	2,400

Calculate the efficiency, capacity and production volume ratios and show how they are linked to each other.

Practice question **14**

A business planned to make 1,200 units at a standard time of 2 hours per unit.

Actual production was 1,100 units.

The actual time taken was 2,250 hours.

Therefore:
During May there were 21 working days of 8 hours per day. The workforce consists of 10 employees, who all do the same work.

Due to problems in the production system and a machine breakdown, 240 hours were recorded as idle time during the month.

During May, the workforce produced 5,400 units of output. The expected time per unit of output is 15 minutes (= 0.25 hours).

Calculate the efficiency, capacity and production volume ratios and show how they are linked to each other.

(Note: The actual hours worked should exclude idle time).

11 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain standard costing using examples
- Explain and construct a flexed budget
- Calculate sales volume variance
- Calculate, analyse and interpret various variances relating to material, labour and factory overhead (both variable and fixed)
- Prepare an operating statement reconcile budgeted profit to actual profit using total absorption costing (TAC) and marginal costing (MC)

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

First calculate the budgeted overhead absorption rate.

Budgeted direct labour hours	**hours**
L: (6,000 units × 1.5 hours)	9,000
H (2,000 units × 3 hours)	6,000
	15,000

Budgeted fixed production overheads	₦1,800,000
Fixed overhead absorption rate/hour	₦120 / hour

	L		**H**	
		₦		**₦**
Direct materials				
Material X	(3 kg × ₦30)	90	(1 kg × ₦30)	30
Material Y	(2 kg × ₦40)	80	(6 kg × ₦40)	240
Direct labour	(1.6 hrs × ₦250)	400	(3 hrs × ₦250)	750
Variable production overhead	(1.6 hrs × ₦50)	80	(3 hrs × ₦50)	150
Standard variable prod'n cost		650		1170
Fixed production overhead	(1.6 hrs × ₦120)	192	(3 hrs × ₦120)	360
Standard full production cost		842		1530

Solutions **2**

The total direct material cost variance is calculated as follows:

	₦
2,000 units of output should cost (× ₦15)	30,000
They did cost	33,600
Total direct materials cost variance	3,600 (A)

The variance is adverse, because actual costs were higher than the standard cost.

Solutions **3**

The price variance is calculated on the quantity of materials purchased/used.

Materials price variance:

	₦	
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 done (i.e. actual cost was higher than the standard or expected cost).

Solutions **4**

Materials usage variance

	litres	
2,000 units of Product P123 should use (× 5 litres)	10,000	
They did use	10,400	
Material usage variance in litres	400	(A)
Standard price per litre of Material A	₦3	
Material usage variance in ₦	₦1,200	(A)

The usage variance is adverse because more materials were used than expected, which has added to costs.

Solutions **5**

	₦	₦
AQ $_{purchased}$ × AC		
10,400 litres × ₦X per kg	33,600	
AQ $_{purchased}$ × SC		2,400 (A) Price variance
10,400 litres × ₦3 per kg	31,200	
AQ $_{used}$ × SC		nil inventory movement
10,400 litres × ₦3 per kg	31,200	
SQ $_{used}$ × SC		1,200 (A) Usage variance
10,000 litres × ₦3 per kg	30,000	

SQ = 2,000 units × 5 litres per unit = 10,000 litres

Solutions **6**

Total direct labour cost variance	**₦**	
3,000 units of output should cost (× ₦6)	18,000	
They did cost	16,200	
Direct labour total cost variance	1,800	(F)

The variance is favourable, because actual costs were less than the standard cost.

The direct labour rate variance is calculated by taking the actual number of hours worked (and paid for).

Direct labour rate variance	**₦**	
1,400 hours should cost (× ₦12)	16,800	
They did cost	16,200	
Direct labour rate variance	600	(F)

The rate variance is favourable because the labour hours worked cost less than they should have done.

The labour efficiency variance, like a materials usage variance, is calculated for the actual number of units produced. The variance in hours is converted into a money value at the standard rate of pay per hour.

Direct labour efficiency variance		
	hours	
3,000 units of Product P234 should take (× 0.5 hours)	1,500	
They did take	1,400	
Efficiency variance in hours	100	(F)
Standard direct labour rate per hour	₦12	
Direct labour efficiency variance in ₦	₦1,200	(F)

The efficiency variance is favourable because production took less time than expected, which has reduced costs.

Labour cost variances: summary	**₦**	
Labour rate variance	600	(F)
Labour efficiency variance	1,200	(F)
Total direct labour cost variance	1,800	(F)

Solutions **7**

	₦'000	₦'000
AH $_{\text{paid for}}$ × AR		
1,400 hours × ₦X per hour	16,200	
AH $_{\text{paid for}}$ × SR		600 (F) Price variance
1,400 hours × ₦12 per hour	16,800	
AH $_{\text{worked}}$ × SR		zero idle time
1,400 hours × ₦12 per hour	16,800	
SH $_{\text{worked}}$ × SR		1,200 (F) Efficiency
1,500 hours × ₦12 per hour	18,000	

SQ = 3,000 units × 0.5 hours per unit = 1,500 hours

Solutions **8**

Total variable production overhead cost variance	**₦**	
2,000 units of output should cost (× ₦3)	6,000	
They did cost	6,550	
Total variable production overhead cost variance	550	(A)

Variable production overhead expenditure variance	**₦**	
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.

Variable production overhead efficiency variance

	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 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)

Solutions **9**

	₦'000	₦'000
AH worked × AR		
2,780 hours × ₦X per hour	6,550	
AH worked × SR		990 (A) Expenditure
2,780 hours × ₦2 per hour	5,560	
SH worked × SR		440 (F) Efficiency
3,000 hours × ₦2 per hour	6,000	

SH = 2,000 units × 1.5 hours per unit = 3,000 hours

Solutions **10**

Standard fixed overhead cost per unit = ₦8 (₦40,000/5,000 units)

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)

Solutions **11**

The standard direct labour hours per unit = 10,000 hours/5,000 units = 2 hours per unit.

The standard fixed overhead rate per hour = ₦40,000/10,000 hours = ₦4 per hour.

The standard fixed overhead cost per unit is 2 hours × ₦4 per hour = ₦8 (or ₦40,000/5,000 units).

Fixed overhead efficiency variance

	hours	
5,200 units should take (× 2 hours)	10,400	
They did take	10,250	
Efficiency variance in hours	150	(F)
Standard fixed overhead rate per hour	₦4	
Fixed overhead efficiency variance in ₦	₦600	(F)

Fixed 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 have been produced).

Summary	₦	
Fixed overhead efficiency variance	600	(F)
Fixed overhead capacity variance	1,000	(F)
Fixed overhead volume variance	1,600	(F)

Solutions **12**

The sales price variance and sales volume variance are calculated as follows.

Sales price variance	₦	
7,200 units should sell for (× ₦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:		
	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.

Solutions **13**

The three ratios are calculated as follows:

$$\text{Efficiency ratio} = \frac{(1{,}100 \times 2 \text{ hours}) = 2{,}200 \text{ hours}}{2{,}250 \text{ hours}} \times 100 = 97.78\%$$

$$\text{Capacity ratio} = \frac{2{,}250 \text{ hours}}{(1{,}200 \times 2 \text{ hours}) = 2{,}400 \text{ hours}} \times 100 = 93.75\%$$

$$\text{Production volume ratio} = \frac{(1{,}100 \times 2 \text{ hours}) = 2{,}200 \text{ hours}}{2{,}400 \text{ hours}} \times 100 = 91.67$$

Using answers obtained above:

Labour efficiency ratio	97.78%
Capacity utilisation ratio	× 93.75%
Production volume ratio	91.67%

Solutions **14**

	Hours
Actual hours to make actual production (10 employees × 21 days × 8 hours) – 240 hours	1,440
Expected time to make the actual production (5,400 units should have used 0.25 hours per unit)	1,350
Total number of hours expected to be used (10 employees × 21 days × 8 hours)	1,680

The three ratios are calculated as follows:

$$\text{Efficiency ratio} = \frac{1{,}350 \text{ hours}}{1{,}440 \text{ hours}} \times 100 = 93.75\%$$

$$\text{Capacity ratio} = \frac{1{,}440 \text{ hours}}{1{,}680 \text{ hours}} \times 100 = 85.71\%$$

$$\text{Production volume ratio} = \frac{1{,}350 \text{ hours}}{1{,}680 \text{ hours}} \times 100 = 80.35$$

Using answers obtained above

Labour efficiency ratio	93.75%
Capacity utilisation ratio	× 85.71%
Production volume ratio	80.35%

Skills level
Performance management

CHAPTER 8

Advanced variance analysis

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

B	**Planning and control**			
	2	**Variance analysis**		
		D	Calculate and apply the following variances:	
			Ii	Material mix and yield variances;
			Vii	Sales mix and quantity variances;
			Viii	Sales market size and market share variances; and
			Ix	Planning and operational variances.
		E	Identify and explain causes of various variances and their inter-relationship.	
		F	Analyse and reconcile variances using absorption and marginal costing techniques	

Exam context

This chapter explains more advanced types of variance analysis.

By the end of this chapter, you should be able to:

- Calculate and interpret material mix and yield variances
- Calculate and interpret sales mix and quantity variances
- Calculate and interpret planning and operational variances

1 MATERIALS MIX AND YIELD VARIANCES

Section overview

- Introduction
- Direct materials mix variance
- Direct materials yield variance
- Summary
- Alternative method
- Factors to consider when changing the mix

1.1 Introduction

When standard costing is used for products which contain two or more items of direct material, the total materials usage variance can be calculated by calculating the individual usage variances in the usual way and adding them up (netting them off).

Example: Usage variances

Product X is produced from three direct materials, A, B and C that are mixed together in a process. The following information relates to the budget and output for the month of January

Standard cost:				Actual:
Material	**Quantity**	**Standard price per kilo**	**Standard cost**	**Quantity used**
	kg	₦	₦	kg
A	1	20	20	160
B	1	22	22	180
C	8	6	48	1,760
	10		90	2,100
Output	1 unit			200 units

Usage variances can be calculated in the usual way:

Making 200 units should have used:	A (kgs)	B (kgs)	C (kgs)
200×1 kg of A	200		
200×1 kg of B		200	
200×8 kgs of C			1,600
Making 200 units did use:	(160)	(180)	(1,760)
Usage variance in kgs	40 (F)	20 (F)	(160) (A)
Standard cost per kg (₦)	20	22	6
Usage variance in ₦	800 (F)	440 (F)	(960) (A)

Total usage variance = ₦280 (F) (800 + 440 -960)

Substitutable materials

If the materials are substitutable (i.e. less of one type of material can be compensated for by more of another) the direct materials usage variance can be analysed into:

- a materials mix variance; and
- a materials yield variance

The total of these two variances is the total material usage variance.

It is vital to understand that this further analysis should only be performed if the materials can be substituted for each other. 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.

For example, in the above example fewer kilograms of A than expected were used to make 200 units but more of B and C.

In contrast if a company manufactured a car no number of extra tyres could compensate for one less engine!

1.2 Direct materials mix variance

The materials mix variance measures how much of the total usage 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 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 material mix variance indicates the effect on profits of having an actual materials mix that is different from the standard material mix.

The materials mix variance is calculated as follows (making reference to the example above):

1) Take the total quantity of all the materials used (2,100 kgs in the example) 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 (1:1:8 in the above example).
2) 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.
3) The mix variance for each material (expressed in kgs) is the difference between the quantity of each material actually used and the quantity of that material that should have been used in the standard mix. The total mix variance in material quantities is always zero.
4) Convert the mix variance for each individual material into a money value by multiplying by the standard price per unit of the material.
5) These figures are summed to give the total mix variance

Example: Mix variance

Material	Actual mix (kgs)	Standard mix	Mix variance (kgs)	Std. cost per kg	Mix variance (₦)
A	160	(10% × 2,100) 210	50 (F)	20	1,000 (F)
B	180	(10% × 2,100) 210	30 (F)	22	660 (F)
C	1,760	(80% × 2,100) 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.

1.3 Direct materials yield variance

The materials yield variance is the difference between the actual yield from a given input and the yield that the actual input should have given in standard terms. It indicates the effect on costs of the total materials inputs yielding more or less output than expected.

The yield variance can be calculated in several ways. No one method is better than any other (use the one that makes most sense to you).

Working

Based on the above example note that:

- The standard cost of each unit (kg) of input = ₦90/10kgs = ₦9 per kilo
- The standard cost of each unit of output = ₦90 per unit

Method 1: Based on output

This compares the actual yield to the expected yield from the material used. The difference is then valued at the standard cost of output.

In the above example 10 kgs of material should result in 1 unit of output.

Therefore, 2,100 kgs of material in should result in 210 units of output.

The difference between this figure and the actual output is the yield variance as a number of units. This is then multiplied by the expected cost of a unit of output.

Example: Yield variance

	Units	
2,100 kgs of input should yield (@10 kgs per unit)	210	
2,100 kgs of input did yield	200	
Yield variance (units)	10	(A)
Standard cost of output	₦90	
Materials yield variance (₦)	₦900	(A)

Method 2: Based on inputs

This compares the actual usage to achieve the yield to the expected usage to achieve the actual yield. The difference is then valued at the standard cost of input.

In the above example 1 unit should use 10 kgs of input.

Therefore, 200 units should use 2,000 kgs of input.

The difference between this figure and the actual input is the yield variance as a number of units. This is then multiplied by the expected cost of a unit of output.

Example: Yield variance

	Units	
200 units of product X should use (× 10 kgs)	2,000	
did use	2,100	
Yield variance in quantities	100	(A)
Standard cost of input	₦9/kg	
Yield variance in money value	₦900	(A)

1.4 Summary

Example: Mix variance + yield variance = usage variance

	₦	
Mix variance	1,180	(F)
Yield variance	(900)	(A)
Usage variance (= mix + yield variances)	280	(F)

Practice question **1**

Product X is produced from two direct materials, X and Y that are mixed together in a process.

The following information relates to the budget and output for the month of July.

Standard				Actual:
Material	**Quantity**	**Standard price per litre**	**Standard cost**	**Quantity used**
	litres	₦	₦	litres
X	12	250	3,000	984
Y	18	300	5,400	1,230
	30		8,400	2,214
Output	1 unit			72 units

Calculate the direct materials mix and yield variances.

1.5 Alternative method

An alternative approach is to use a line by line method.

This starts with the standard cost of the actual quantity used in the actual mix.

This figure is made up as:

- Actual Quantity (AQ) in the Actual Mix (AM) at the Standard Cost per unit (SC)
- Elements of this are then changed in sequence to identify the variances. In the table below the element that changes has been written in bold.

Example: Mix and yield variances

	AQ in AM	@	SC			
	kgs		₦	₦		
A	160	×	20	3,200		
B	180	×	22	3,960		
C	1,760	×	6	10,560		
	2,100			17,720		
	AQ in **SM**	@	SC			
A (0.1)	**210**	×	20	4,200	**1,180 F**	**MIX**
B (0.1)	**210**	×	22	4,620		
C (0.8)	**1,680**	×	6	10,080		
	2,100			18,900		
	SQ in SM	@	SC			
A (0.1)	**200**	×	20	4,000		
B (0.1)	**200**	×	22	4,400	**900 A**	**YIELD**
C (0.8)	**1,600**	×	6	9,600		
	2,000[1]			18,000		

[1] This figure is the number of kgs that making 200 units should have used.

At first sight this seems to be a very long winded technique. However, some of the calculations can be simplified by using the standard costs of input or output.

The calculation then becomes:

Example: Mix and yield variances

	AQ in AM kgs	@	SC ₦	₦		
A	160	×	20	3,200		
B	180	×	22	3,960		
C	1,760	×	6	10,560		
	2,100			17,720		
	AQ in **SM**	@	SC of input		**1,180 F**	**MIX**
	2,100		9	18,900		
	SQ in SM	@	SC of input		**900 A**	**YIELD**
	2,000		9	18,000		
	or		SC of output			
	200 units		90	18,000		

You are encouraged to use the above method as it is much quicker.

1.6 Factors to consider when changing the mix

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.

Practice question **2**

Product X is produced from two direct materials, X and Y that are mixed together in a process.
The following information relates to the budget and output for the month of July.

Standard				Actual:
Material	**Quantity**	**Standard price per litre**	**Standard cost**	**Quantity used**
	litres	₦	₦	litres
X	12	250	3,000	984
Y	18	300	5,400	1,230
	30		8,400	2,214
Output	1 unit			72 units

Calculate the direct materials mix and yield variances using the line by line method.

2 SALES VOLUME, MIX AND QUANTITY VARIANCES

Section overview

- Sales volume variance
- The sales quantity variance
- The sales mix variance
- Alternative method

2.1 Sales volume variance

When a company sells more than one product a volume variance can be calculated for each individual product in the usual way. In such cases the total sales volume variance is then the sum of the individual sales volume variances.

Example: Sales volume variance

The following information relates to the sales budget and actual sales volume results for X Ltd for the month of March.

Product	X	Y	Z	Total
Budgeted sales (units)	240	140	120	500
Unit contribution	₦50	₦70	₦60	
Total contribution	₦12,000	₦9,800	₦7,200	₦29,000
Standard average contribution per unit (₦29,000/500 units)				₦58
Actual sales (units)	200	220	180	600

The individual sales volume variances and the total sales volume variance for the month of March are as follows:

Sales volume variances

	X	Y	Z	
Actual sales (units)	200	220	180	
Budgeted sales (units)	240	140	120	
Volume variance (units)	(40) A	80 F	60 F	
Standard contribution per unit	₦50	₦70	₦60	
Volume variance (contribution)	(₦2,000)	₦5,600	₦3,600	
Total				₦7,200

In the above example, there are two differences between the budgeted unit sales and the actual unit sales. Firstly, the budget was to sell 500 units whereas the company has actually sold 600 units. The second difference is that the company had budgeted to sell 500 units containing a budgeted mix of units X, Y and Z but they have actually sold 600 units with a different mix of these items.

The total sales volume variance can be analysed into:

- a sales quantity variance; and
- a sales mix variance.

2.2 The sales quantity variance

The sales quantity variance indicates the effect on profits of the total quantity of sales being different from that budgeted, assuming that they are sold in the budgeted sales mix. If this was the case the average standard contribution per unit would be the same as budgeted.

The quantity variance is calculated as follows:

Illustration: Sales quantity variance

	Units
Budgeted sales in total	X
Actual sales in total	(X)
Sales quantity variance in units	X
Weighted average standard contribution per unit	₦X
Sales quantity variance (in standard contribution)	₦X

Example: Sales quantity variance

Returning to the facts from the previous example the sales quantity variance is calculated as follows:

	Units	
Budgeted sales in total	500	
Actual sales in total	600	
Sales quantity variance in units	100	(F)
Weighted average standard contribution per unit	₦58	
Sales quantity variance (in standard contribution)	₦5,800	(F)

2.3 The sales mix variance

The sales mix variance indicates the effect on profits of having an actual sales mix that is different from the budgeted sales mix.

The sales mix variance is calculated as follows (making reference to the example above):

1) Find the budgeted mix in percentage terms by summing the budgeted sales of each individual product and calculating the percentage that each bears to the total (**X**: $^{240}/_{500}$ = 48%; **Y**: $^{140}/_{500}$ = 28%; **Z**: $^{120}/_{500}$ = 24%).

2) Apply the percentages to the actual total sales to give the actual number of each that would have been sold if the actual sales were made in the standard mix. (For X this figure is 48% of 600 = 288 units).

3) The mix variance (in units) for each product is the difference between this number and the actual sales of that product. (For X this is 240 – 288 = 48 units. This means that the company has sold 48 units of X less than it would have if the actual sales were made in the standard mix).

4) The variance for each product expressed as units is multiplied by the standard contribution per unit of that product to give the impact on contribution.

5) These figures are summed to give the total mix variance

Example: Sales mix variance

Returning to the facts from the previous example the sales mix variance is calculated as follows:

Product	Actual mix	Standard mix	Mix variance (units)	Std. cont^n per unit	Mix variance (Std cont^n)
	units	units	units	₦	₦
X (48%)	200	288	88 (A)	50	4,400 (A)
Y (28%)	220	168	52 (F)	70	3,640 (F)
Z (24%)	180	144	36 (F)	60	2,160 (F)
	600	600	0		1,400 (F)

The total mix variance in units must come to zero.

In this illustration the total mix variance is favourable because the company has sold more high contribution items and less low contribution items.

The total of the sales mix variance and the sales quantity variance adds up to the total sales volume variance.

Example: Sales quantity variance

	₦	
Sales mix variance	1,400	(F)
Sales quantity variance	5,800	(F)
Sales volume variance	7,200	(F)

2.4 Alternative method

An alternative approach is to use a line by line method.

This starts with the expected contribution from the actual sales of each unit.

This figure is Actual Quantity (AQ) in the Actual Mix (AM) at the Standard Contribution per unit (SC)

Elements of this are then changed in sequence to identify the variances. In the table below the element that changes has been written in bold.

Example: Sales mix and quantity variances

	AQ in AM units	@	SC ₦	₦		
X	200	×	50	10,000		
Y	220	×	70	15,400		
Z	180	×	60	10,800		
	600			36,200		
	AQ in **SM**	@	SC			
X (0.48)	**288**	×	50	14,400	**1,400 F**	**MIX**
Y (0.28)	**168**	×	70	14,760		
Z (0.24)	**144**	×	60	8,640		
	600			34,800		
	SQ in SM	@	SC			
X (0.48)	**240**	×	50	12,000	**5,800 F**	**QUANTITY**
Y (0.28)	**140**	×	70	9,800		
Z (0.24)	**120**	×	60	7,200		
	5,000			29,000		

At first sight this seems to be a very long winded technique. However, some of the calculations can be simplified by using the budgeted average standard contribution per unit (₦58).

This figure can be used whenever the contribution from a total quantity is to be expressed in Standard Mix @ Standard Contribution per unit. The calculation then becomes:

Example: Sales mix and quantity variances

	AQ in AM Units	@	SC ₦	₦		
X	200	×	50	10,000		
Y	220	×	70	15,400		
Z	180	×	60	10,800		
	600			36,200		
					1,400 F	**MIX**
	AQ in **SM**	@	SC			
	600		58	34,800		
					5,800 F	**QUANTITY**
	SQ in SM	@	SC			
	500		58	29,000		

3 PLANNING AND OPERATIONAL VARIANCES

Section overview

- 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
- Alternative approaches
- More than one difference between the ex ante and ex post standard costs
- Analysing the planning variance

3.1 The reasons for planning and operational variances

Variance analysis serves to identify levels of performance, costs etc. that have been different to those budgeted. The aim is to 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 quality of the information provided by variance analysis depends on the quality of the budget being used as a basis for comparison. For example, if the standard steel usage for making a bulldozer was set at 10 kgs there would obviously be huge adverse material usage variances (as making a bulldozer uses much more than 10 kgs of steel). There would be no point taking the production manager to task over the adverse variance as it was simply not possible to build bulldozers using this amount of steel. It is the budget that is at fault. This is perhaps a silly example but it serves to illustrate an important point. If management are taking action based on variances those variances should reflect operational issues and not arise as a result of a flawed plan.

If a budget or standard is unreliable, the variance reports will also be unreliable – and so of limited use to management.

3.2 Ex ante and ex post standards or budgets

If management decides 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**.

Variances are usually calculated by comparing actual results to an ex ante budget. This process might reveal variances which on further investigation are due to the budget being unrealistic rather than due to operating factors. When this is the case a new, more realistic budget (the ex post budget) is drafted for the period that has already past and this allows the calculation of more reasonable variances.

3.3 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**.

It is important to remember that there is nothing new to learn in calculating operational variances (in fact, all variance calculated so far have been operational variances). The calculation of operational variances is exactly the same as already described but comparing actual results to the new ex post budget.

3.4 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 and explain the issue and the method of calculating planning and operational variances.

Example: Planning and operational variances

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 did cost	16,500	
but, 1,960 hours should cost (× ₦8)	15,680	
Labour rate variance	820	(A)

Labour efficiency variance	**hours**	
500 units of product Z did take	1,960	
but, 500 units of product Z should take (× 3 hours)	1,500	
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).

In the usual course of events a variance might be investigated and the manager responsible for the part of the business within which the variance arose might be taken to task over an adverse variance.

Suppose, however, that it is discovered early during the month that planned improvements in efficiency that were expected from introducing new equipment and were introduced into the budget could not be achieved, because the new equipment had suffered a major breakdown and had been returned to the supplier for repair.

This means that the budget used above could not be achieved in the period. With hindsight the budgeted labour cost for each unit of Product Z should have been: 4 hours × ₦8 per hour = ₦32.

Variances are recalculated using this as a **new ex post standard cost** for direct labour cost.

Operational variances

Operational variances are calculated exactly as before but using the ex post budget.

The planning variance is the difference between:

- the original standard cost of making the actual production (the ex ante standard cost or ex ante budget of actual production), and
- the revised standard cost or budget of making the actual production (the ex post standard cost or ex post budget of actual production).

Example: Operational variances

Labour rate variance	**₦**	
1,960 hours did cost	16,500	
but, 1,960 hours should cost (× ₦8)	15,680	
Labour rate variance (as before as the ex ante budget cost per hour has not been revised)	820	(A)

Labour efficiency 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 ₦	₦320	(F)

The calculation of the labour efficiency variance using the ex post budget shows a very different picture showing a favourable variance as opposed to the adverse variance shown by comparison to the original budget. The manager responsible should be congratulated rather than admonished!

Planning variances

The planning variance is not a very useful figure other than being part of the reconciliation between actual results and the ex ante cost of achieving those results. (It is not a useful figure as the fact that it has been calculated means that management already knows that the budget was suspect. Knowing the size of the difference is not particularly helpful in running the business).

The planning variance is reported as the effect that this difference has had on reported profit or cost.

Since direct labour is a variable cost, the planning variance is calculated as the difference between:

- the standard labour cost of actual production at the ex ante standard, and
- the standard labour cost of actual production with the ex post standard.

Example: Planning variances

Method 1

Total labour cost for 500 units of Z	**₦**
Ex post standard cost (× ₦32)	16,000
Ex ante standard cost (× ₦24)	12,000
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 Z	**hours**
Ex post standard (× 4 hours)	2,000
Ex ante standard (× 3 hours)	1,500
Planning variance in standard hours	500 (A)
Standard labour rate per hour	₦8
Planning variance in ₦, labour efficiency	₦4,000 (A)

Summary

The planning and operational variances in the previous example can be summarised as follows:

Example: Variances under traditional and planning/operational methods

	Traditional		Planning and operational	
Operational variances	₦		₦	
Labour efficiency	3,680	(A)	820	(A)
Labour rate	820	(F)	320	(F)
Planning variance (labour efficiency)			4,000	(A)
Total	4,500	(A)	4,500	(A)

The total variances come to the same amount.

In this case the 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.

3.5 Alternative approach

An alternative approach is to use a line by line method.

This starts with actual cost. One factor is changed at a time using the ex post standard usage and cost. A final line is inserted as the ex ante standard cost of the actual production.

Example: Alternative method identifying planning and operational variances

Ex ante standard material cost per unit:

3 hours × ₦8 per hour = ₦24 per unit

Actual production in period = 500 units.

Labour worked and paid for was 1,960 hours to make 500 units, at a labour cost of ₦16,500

Ex post standard material cost per unit:

4 hours × ₦8 per hour = ₦32 per unit

	₦	₦
AQ × AC		
1,960 hrs × ₦X per hr	16,500	
AQ × SC		820 (A) Price
1,960 hrs × ₦8 per hr	15,680	
$SQ_{\text{ex post}}$ × SC		320 (F) Usage
2,000 hrs × ₦8 per hr	16,000	
$SQ_{\text{ex ante}}$ × SC		4,000 (A) Planning
1,500 hrs × ₦8 per hr	12,000	

Ex post standard quantity to make actual production

SQ = 500 units × 4 hrs per unit = 2,000 hrs

Ex ante standard quantity to make actual production

SQ = 500 units × 3 hrs per unit = 1,500 hrs

You are encouraged to use this approach as an alternative method.

3.6 More than one difference between the ex ante and ex post standard costs

In the above example only the standard usage changed between the ex ante and ex post budgets. A situation could arise where both standard usage and standard cost changed.

The principle to apply in calculating the planning and operational variances is the same as before.

- ❑ The operational variances are calculated using the ex post standard cost.
- ❑ The planning variance in total is the difference between the ex ante standard cost of actual production and the ex post standard cost of actual production.

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 though the resultant figures are not really useful.

The following example shows the calculation of planning and operational variances when two factors change between the ex ante and ex post budgets. In the first instance only the total planning variance will be calculated. Analysis of the planning variance will follow that.

This will be worked using the line by line approach.

Example: Planning and operational variances

Greenco Nigeria Limited 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.

Investigation of the resultant variances has shown that the original standard was unrealistic and should have been 4 kilos at ₦7 per kilo = ₦28.

The planning and operational variances can be identified as follows.

	₦	₦
AQ × AC		
16,500 kgs × ₦X per kg	119,000	
AQ × SC		3,500 (A) Price
16,500 kgs × ₦7 per kg	115,500	
$SQ_{\text{ex post}} \times SC_{\text{ex post}}$		3,500 (A) Usage
16,000 kgs × ₦7 per kg	112,000	
$SQ_{\text{ex ante}} \times SC_{\text{ex ante}}$		8,000 (F) Planning
20,000 kgs × ₦6 per kg	120,000	

Ex post standard quantity to make actual production

SQ = 4,000 units × 4 kgs per unit = 16,000 kgs

Ex ante standard quantity to make actual production

SQ = 4,000 units × 5 kgs per unit = 20,000 kgs

3.7 Analysing the planning variance

In the above example, the difference between the ex ante standard cost per unit and the ex post standard cost per unit is due to both price and usage. This implies that the total planning variance can be analysed into a price planning and price usage variance.

This is done by changing one factor between the ex ante standard cost of actual production and the ex post standard cost of actual production. Either the usage or cost of each unit of resource might be changed. Changing one, as opposed to the other, results in a different split of the price planning and price usage variances.

This is difficult to understand until you see an example.

Example: Analysing planning variance

Returning to the previous example the total planning variance may be split as follows.

Changing price first

$SQ_{ex\ post} \times SC_{ex\ post}$	₦	₦
16,000 kgs × ₦7 per kg	112,000	
$SQ_{ex\ post} \times SC$		16,000 (A) Planning price
16,000 kgs × ₦6 per kg	96,000	
$SQ_{ex\ ante} \times SC_{ex\ ante}$		24,000 (F) Planning usage
20,000 kgs × ₦6 per kg	120,000	

Changing usage first

$SQ_{ex\ post} \times SC_{ex\ post}$	₦'000	₦'000
16,000 kgs × ₦7 per kg	112,000	
$SQ_{ex\ post} \times SC$		28,000 (F) Planning price
20,000 kgs × ₦7 per kg	140,000	
$SQ_{ex\ ante} \times SC_{ex\ ante}$		20,000 (A) Planning usage
20,000 kgs × ₦6 per kg	120,000	

In the above example the total planning variance is being split in different ways.

Practice question **3**

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.

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 the month is 10,000 units of product K, and these took 2,650 hours to make. The actual direct labour cost was ₦51,600.

Analyse the total direct labour variance into operational variances and a planning variance.

4 MARKET SHARE AND MARKET SIZE VARIANCES

Section overview

- Further analysis of sales volume variance
- Market size variance
- Market share variance
- Alternative method

4.1 Further analysis of sales volume variance

Sales volume is a function of market share and market size. If the original budget derives budgeted sales volume from budgeted market share and budgeted market size it should be possible to split the sales volume variance into a market share variance and a market size variance.

The total size of the market is a factor that is largely outside a company's control but is estimated at the start of the period. The market size variance is therefore a planning variance. Note that the ex post budgeted market size is the actual size of the market. If the business had been better at forecasting the market size this is what they would have expected.

The market share obtained by a company is under the influence of management (through marketing activities). The market share variance is an operational variance.

Example: Sales volume variance

Colorco Nigeria Limited set the following sales budget to sell 70,000 units of Product Y and budgeted to earn a contribution per unit of ₦20

Colorco Nigeria Limited 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 of Product Y by Colorco Nigeria Limited in the period = 58,000 units Total market size of Product Y = 645,000 units

In retrospect, it is accepted that the budget should have been based on a total market size of 645,000 units.

The traditional sales volume variance is calculated as follows:

	Units	
Actual sales volume	58,000	
Budgeted sales volume	70,000	
Sales volume variance (units)	12,000	(A)
Standard contribution per unit (multiply by)	₦20	
Sales volume variance (in contribution)	₦240,000	(A)

4.2 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 units of sale or 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: Market size variance

Returning to the previous example the market size variance is calculated as follows:

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)

4.3 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: Market share variance

Returning to the previous example the market share variance is calculated as follows:

Market share variance	units	
Ex post (actual) total market size	645,000	
Budgeted market share	10%	
Expected sales if budgeted market share achieved	64,500	
Actual sales	58,000	
Market share variance (units)	6,500	(A)
Standard contribution per unit	₦20	
Market share variance in ₦ contribution	₦130,000	(A)

The market size variance and the market share variance together add up to the total sales volume variance for the period.

Example: Summary

	Units		CPU	₦
Market size variance	5,500	(A)	20	110,000
Market share variance	6,500	(A)	20	130,000
Total sales volume variance	12,000	(A)	20	240,000

Practice question **4**

Brunco Nigeria Limited prepared a sales budget based on an estimated market size of 200,000 units and a budgeted market share of 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.

4.4 Alternative method

The market share and market size variances can be identified using a line by line approach. This starts with the actual sales volume (actual market share of actual market size) and ends with the budgeted sales volume (standard market share of standard market size). It is easier to measure the variances in units and then apply a standard contribution to express these variances as monetary amounts.

Remember that the actual units sold is a function of the actual market size and this is the ex post forecast of market size.

Example: Alternative method for identifying market share and market size variances

Returning to the previous example the market share variance and market size variances (in units) are calculated as follows:

	Units	
Actual market size × Actual market share		
645,000 units × X%	58,000	
		Market share 6,500 units (A)
Actual market size × standard market share		
645,000 units × 10%	64,500	
		Market size 5,500 units (A)
Budgeted market size × standard market share		
700,000 units × 10%	70,000	

Practice question **5**

Brunco Nigeria Limited prepared a sales budget based on an estimated market size of 200,000 units and a budgeted market share of 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

Use the alternative method to calculate:

(a) the total sales volume variance

(b) the market size variance

(c) the market share variance.

5 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Calculate and interpret material mix and yield variances
- Calculate and interpret sales mix and quantity variances
- Calculate and interpret planning and operational variances

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

Mix variance

Material	Actual mix (litres)	Standard mix	Mix variance (litres)	Std. cost per litre	Mix variance (₦)
X	984	(40% × 2,214) 885.6	98.4 (A)	250	24,600 (A)
Y	1,230	(60% × 2,214) 1,328.4	98.4 (F)	300	29,520 (F)
	2,214	2,100	0		4,920 (F)

Yield variance based on output

	Units	
2,214 litres of input should yield (@30 litres per unit)	73.8	
2,100 litres of input did yield	72.0	
Yield variance (units)	1.8	(A)
Standard cost of output	₦8,400	
Materials yield variance (₦)	₦15,120	(A)

Yield variance based on input

	litres	
Making 72 units did use	2,214	
but, making 72 units of product X should use (× 30 litres)	2,160	
Yield variance in quantities	54	(A)
Standard cost of input (₦8,400/30 litres)	₦280/litre	
Yield variance in money value	₦15,120	(A)

Solution **2**

	AQ in AM	@	SC			
	litres		₦	₦		
X	984	×	250	246,000		
Y	1,230	×	300	369,000		
	2,214			615,000		
	AQ in **SM**	@	SC			
X (0.4)	**885.6**	×	250	221,400		
Y (0.6)	**1,328.4**	×	300	398,520		
	2,214			619,920	**4,920 F**	**MIX**
	SQ in SM	@	SC			
X (0.4)	**864**	×	250	216,000		
Y (0.6)	**1,296**	×	300	388,800		
	2,160			604,800	**15,120 A**	**YIELD**

Making 72 units should use 72 units × 30 litres per unit = 2,160 litres.

Quicker version:

	AQ in AM	@	SC			
	litres		₦	₦		
X	984	×	250	246,000		
Y	1,230	×	300	369,000		
	2,214			615,000		
	AQ in **SM**	@	SC of input			
	2,214		₦8,400/30 litres	619,920	**4,920 F**	**MIX**
	SQ in SM	@	SC of input			
	2,160		₦8,400/30 litres	604,800	**15,120 A**	**YIELD**
	or		SC of output			
	72 units		8,400	604,800		

Solution **3**

	₦'000	₦'000
AQ × AC		
2,650 hrs × ₦X per hr	51,600	
AQ × SC		1,400 (F) Price
2,650 hrs × ₦20 per kg	53,000	
SQ $_{ex\ post}$ × SC $_{ex\ post}$		3,000 (A) Usage
2,500 hrs × ₦20 per kg	50,000	
SQ $_{ex\ ante}$ × SC $_{ex\ ante}$		2,000 (A) Planning
3,000 hrs × ₦16 per kg	48,000	

Ex post standard quantity to make actual production

SQ = 10,000 units × 0.25 hrs per unit = 2,500 hrs

Ex ante standard quantity to make actual production

SQ = 10,000 units × 0.3 hrs per unit = 3,000 hrs

Solution **4**

	units	
Actual sales volume	61,000	
Budgeted sales volume (25% × 200,000)	50,000	
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 post (actual) total market size	260,000	
Ex ante (budgeted) total market size	200,000	
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%	
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)

Solution **5**

	Units	
Actual market size × Actual market share		
260,000 units × X%	61,000	
		Market share 4,000 units (A)
Actual market size × standard market share		
260,000 units × 25%	65,000	
		Market size 15,000 units (F)
Budgeted market size × standard market share		
200,000 units × 25%	50,000	

Total sales volume variance:	Units	Contribution (@₦40)
Market share variance	4,000 (A)	(160,000)
Market size variance	15,000 (F)	600,000
Total sales volume variance	11,000 (F)	440,000

CHAPTER 9

Performance analysis

Contents

INTRODUCTION

Aim

Performance analysis develops and deepens candidates' ability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Much of the work involved in performance analysis involves short-term reviews, for example comparisons of actual performance against a budget or target, or comparisons with previous time periods. However, there is also a longer-term or strategic aspect to performance management. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions, and also to consider the strategic implications of performance indicators for the long-term success of an organisation.

Detailed syllabus

The detailed syllabus includes the following:

C	**Performance measurement and control**		
	1	**Performance analysis**	
		a	Select and calculate suitable financial performance measures for a business from a given data and information.
		b	Evaluate the results of calculated financial performance measures based on business objectives and advise management on appropriate actions.
		c	Select and calculate suitable non-financial performance measures for a business from a given data and information.
		d	Evaluate the results of calculated non-financial performance measures based on business objectives and advise management on appropriate actions.
		e	Explain the causes and problems created by short-termism and financial manipulation of results and suggest methods to encourage a long term view.
		f	Discuss sustainability consideration in performance measurement of a business.
		g	Select and explain stakeholders based measures of performance that may be used to evaluate social and environmental performance of a business.
		h	Explain and interpret the Balanced Scorecard and Fitzgerald and Moon Building Block model.

Exam context

This chapter explains various approaches to entity performance analysis, and its application to performance management, for both for-profit and not-for-profit organisations. It also looks at the longer-term or strategic implications of performance.

By the end of this chapter, you should be able to:

- Explain the nature of performance and non-performance indicators in a performance management system
- Measure and use a range of financial performance indicators
- Measure and use a range of non-financial performance indicators
- Explain the nature of short-termism in performance measurement
- Explain the relevance of sustainability measurements (social and environmental measurements) for an assessment of longer-term performance
- Explain the balanced scorecard approach to performance management and apply it in a given scenario
- Explain the Fitzgerald and Moon Building Block model and its application to performance measurement in service industries

1 MEASURING PERFORMANCE

Section overview

- Performance and performance management
- Financial performance
- Non-financial performance
- Performance management systems

1.1 Performance and performance management

Performance of an organisation is concerned with what the organisation has done or expects to do, and with how well this compares with a target or budget, or with past performance, or with long-term (strategic) objectives.

Performance management is concerned with:

- setting targets for performance;
- monitoring actual performance and progress towards the targets; and
- taking control measures when actual performance is worse than expected.

Performance is measured, and measurements may be both financial and non-financial.

1.2 Financial performance

Financial performance for an organisation is concerned with the extent to which the financial objectives of the organisation are being met. Performance is measured in financial/monetary terms.

- For most businesses, the main objective is to make a profit or return on capital invested. Financial performance is concerned with the factors that contribute to profitability and return, such as sales and costs, as well as profits and return.
- Not-for-profit organisations such as government and charities do not have an objective of making a profit. However, financial performance is relevant to them too, in terms of keeping spending within the limits of the money or funds available to them, and using the money that they have in the best way they can.

1.3 Non-financial performance

Non-financial performance is performance that is not measured in financial or monetary terms, although non-financial performance can be a contributing factor to overall financial performance.

Examples of non-financial performance in business are output capacity, labour productivity, labour turnover, customer satisfaction and innovation.

Organisations measure non-financial performance as well as financial performance.

1.4 Performance management systems

Performance management systems are constructed to drive the behaviour of employees so that the company achieves its corporate objectives.

Performance management systems have a key role to play in many aspects of strategic planning and are concerned with:

- setting targets for the achievement of the organisation's main strategic objective;
- setting targets for each strategy that is implemented for achieving the main strategic objective;
- setting targets at all levels of management within the organisation: all planning targets (at all levels within the entity) should be consistent with the strategic targets and objectives;
- measuring actual performance;
- comparing actual performance with the targets;
- where appropriate, taking control measures; and
- where appropriate, changing the targets.

Performance management is therefore concerned with planning and controlling, at all levels within an organisation.

A business entity must have management information systems that are capable of providing reliable and relevant information about all the important aspects of performance.

Performance targets are set, and actual performance is measured, by means of performance indicators. These may be financial or non-financial, and non-financial indicators may be either quantitative or qualitative. A key performance indicator (KPI) is a measure of performance that is considered critically important for achieving success or progress in relation to a specified goal.

It is important to understand that performance measurement can indicate when aspects of performance are much better or much worse than expected, but they do not usually indicate the reason for the good or bad performance. When performance measures indicate an unexpected difference between actual and expected performance, management should investigate the reason or reasons for the difference and take any appropriate measures when they discover the cause of the problem.

2 FINANCIAL PERFORMANCE INDICATORS (FPIs)

Section overview

- Performance indicators: definition
- Aspects of financial performance
- Using ratios: comparisons
- FPIs for measuring profitability
- FPIs for measuring liquidity
- FPIs for measuring financial risk
- The limitations of financial ratios as performance indicators
- Industry specific ratios

2.1 Performance indicators: definition

A performance indicator is a performance measurement that is used to evaluate the success of an organisation or of a particular activity. A financial performance indicator is an indicator that relates to an aspect of financial performance that is measured quantitatively and in financial terms.

2.2 Aspects of financial performance

There a variety of financial performance indicators that could be used by the management of a business. These include:

- Absolute measures, such as sales turnover, costs and profit;
- Financial ratios;
- Variances (differences between actual and expected performance).

Performance is assessed by comparing indicators of actual performance with indicators of budgeted or expected performance, or with indicators of past performance. Comparisons with past performance indicate whether performance is improving or getting worse.

This chapter focuses on the use of ratios for performance measurement.

Ratio analysis

Ratio analysis is a common method of analysing and measuring the financial performance of an organisation. 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 in a for-profit organisation are usually:

- profitability;
- liquidity; and
- financial risk.

Information for measuring financial performance is obtained largely from internal sources – financial statements produced by the accounting systems of the organisation.

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.

2.3 Using ratios: comparisons

Financial ratios can be used as indicators to make comparisons of performance:

- ❑ Over a number of years or months. By looking at the ratios of a business entity over a number of years or months, it may be possible to detect improvements or 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'.
- ❑ With similar ratios of other, similar companies for the same period.
- ❑ With target ratios or budgeted ratios of financial performance
- ❑ In some cases, perhaps, with 'industry average' ratios.

2.4 FPIs for measuring profitability

Profitability depends on sales revenues and costs. Financial performance indicators that may be relevant for assessing performance 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 later chapter on divisional performance.

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: Sales performance

Laffco Nigeria Limited 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.

Formula: Profit margin

$$\text{Profit margin} = \frac{\text{Profit}}{\text{Sales}} \times 100$$

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.

In some industries, particularly service industries, companies do not measure a cost of sales, and so do not measure a gross profit and gross profit/sales ratio.

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: Profitability analysis

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:

	20X9 (year just ended	20X8	20X7
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.

> **Answer (continued)**
>
> 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 ratios of:

- cost of sales/sales;
- administration costs/sales;
- sales and distribution costs/sales; and
- 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. For example, if the ratio of administration cost/sales increases from 15% to 18%, it should be expected that the net profit margin will fall by 3% (three percentage points).

2.5 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.

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 make 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 the reason for the change 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; and
- 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 liquidity ratios over time. There are two ratios for measuring liquidity that could be used:

- current ratio; and
- 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.

Formula: Current ratio

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

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; and
- 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.

Formula: Quick ratio

$$\text{Quick ratio} = \frac{\text{Current assets excluding inventory}}{\text{Current liabilities}}$$

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; or
- ❑ 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; and
- ❑ using cash to purchase new non-current assets.

Example: Quick and current ratios

The following data relates to a café:

	20X6	**20X7**	20X8
	₦	**₦**	**₦**
Current assets			
Inventories	2,985	3,028	3,211
Other current assets	9.594	9,652	7,660
Total current assets	12,579	12,680	10,871
Current liabilities			
Creditors	19,021	18,604	19,523
Other current liabilities	4,566	4,306	4,414
Total current liabilities	23,587	22,910	23,937

Required:

Calculate the current and quick ratios for the cafe

Answer

The current and quick ratios are as follows

Current ratio

Total current assets	12,579	12,680	10,871
Total current liabilities	÷23,587	÷22,910	÷23,937
Current ratio	0.53	0.55	0.45

Quick ratio

Total current assets	9,594	9,652	7,660
Total current liabilities	÷23,587	÷22,910	÷23,937
Quick ratio	0.41	0.42	0.32

Both the current and quick ratios are stable between 20X6 and 20X7 with a current ratio of around 0.54 and a quick ratio of around 0.41.

Whether the ratios are at an acceptable value or are cause for concern depends on what is normal for the industry.

A business like the café might be able to take credit from its suppliers but is making sales for cash. This allows it to operate with ratios that might appear more worrying in another type of business.

The difference between the current and quick ratios is not really important in this case. The inventory of this sort of business can be turned into cash in a very short time frame and might be considered almost as good as cash in terms of enabling the business to pay its debts as and when they fall due.

Both the current and quick ratios decrease in 20X8 and this sudden deterioration after a period of stability might be might be cause for concern.

2.6 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).

A significant 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.

Example: Financial risk

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?

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.

Formula: Gearing ratio

$$\text{Gearing ratio} = \frac{\text{Long term debt}}{\text{Share capital} + \text{reserves} + \text{long term debt}} \times 100$$

Alternatively:

Formula: Debt to equity ratio

$$\text{Debt to equity ratio} = \frac{\text{Long term debt}}{\text{Share capital + reserves}} \times 100$$

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.

Example: Gearing

Company A and Company B are identical in all respects except their gearing.

Both have assets of ₦30,000 and both make the same operating profit (PBIT).

Company A is financed purely by equity, and Company B is financed by a mixture of debt and equity as follows.

	Company A	Company B
Assets	30,000	30,000
Ordinary shares of ₦1	30,000	20,000
10% bonds		10,000
	30,000	30,000

Company B has to make a profit of at least ₦1,000 in order to be able to pay the interest on the 10% bond.

Company A has no debt, so does not need to cover the interest payments and so does not have any minimum PBIT requirement.

Company B is therefore riskier than company A.

Lower geared companies are less risky than higher geared companies as there is a greater likelihood that its PBIT will be high enough to cover interest charges and make a profit for the shareholders

Interest cover ratio

Interest cover measures the ability of the company to meet its obligations to pay interest.

Formula: Interest cover

$$\text{Interest cover} = \frac{\text{Profit before interest and tax}}{\text{Interest charges in the year}}$$

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.

Example: Gearing and interest cover

The following data relates to All Stores, a large chain of supermarkets.

	20X6	**20X7**	20X8
	₦'000	₦'000	₦'000
Current liabilities			
Short-term debt (at 5%)	11,773	6,402	5,453
Non-current liabilities			
Long-term debt (2%)	41,771	41,086	38,214
Capital and reserves			
Total shareholders' equity (share capital plus reserves)	79,209	81,394	80,546
Earnings before interest and tax (EBIT)	27,260	21,638	20,497

Required

Calculate the gearing and interest cover ratios for All Stores and comment on the results.

Answer

Gearing

Gearing is calculated using the formula:

	20X6	20X7	20X8	
	₦'000	₦'000	₦'000	
Long-term debt	41,771	41,086	38,214	**(1)**
Total shareholders' equity (share capital plus reserves)	79,209	81,394	80,546	
	120,980	122,480	118,760	**(2)**
Gearing ratio (1) as a percentage of (2)	34.53%	33.55%	32.18%	

The gearing level has decreased over the 3 year period.

This shows that All Stores is less reliant on debt to fund its business.

The interest cover at All Store over the three years is as follows:

	20X6	20X7	20X8
	₦'000	₦'000	₦'000
EBIT	27,260	21,638	20,497
Interest			
Short-term debt	11,773	6,402	5,453
Interest at 5%	539	320	273
Long-term debt	41,771	41,086	38,214
Interest at 2%	835	822	764
Total interest in the year	1,374	1,140	1,037
Interest cover (EBIT/Total interest)	19.84	18.98	19.76

The interest level remained fairly stable over the three year period, despite the fall in earnings before interest and tax the company experienced over this time frame.

The company's level of gearing has fallen so interest is still easily be covered by the company despite the fall in earnings.

The figure itself is around 19 times which indicates this company is unlikely to present much risk and could withstand a fall in profits without compromising its ability to repay interest.

2.7 The limitations of financial ratios as performance indicators

There are several limitations or weaknesses in the use of financial ratios for analysing the performance of companies.

- 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 sometimes 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.

2.8 Industry specific ratios

Many of the above financial ratios can be used to analyse performance of different types of company.

There are some financial performance measures which might be used in specific industries. For example:

- annual sales revenue per cubic metre of shelf space (a 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);
- add-on revenue per guest night (hotels).

Example: Industry specific ratios

A company transports grain from the countryside to the capital city.

The following information has been gathered for a period:

Load per lorry	20 tonnes
Distance per trip	300 km
Cost per km	₦500
Total cost (300 km × ₦500)	₦150,000
Tonnes per km (300 km × 20 tonne)	÷6,000 tonnes
Cost per tonne per km	₦25

Note: Tonnes per km – Carrying 20 tonnes for 30 km is the equivalent of carrying 6,000 tonnes for 1 km.

3 NON-FINANCIAL PERFORMANCE INDICATORS (NFPIs)

Section overview

- Non-financial performance indicators
- Non-financial aspects of performance
- Common areas in which companies adopt NFPIs
- NFPIs for departments or functions
- NFPIs in different types of industry
- Analysing NFPIs
- Benchmarking

3.1 Non-financial performance indicators

Financial performance alone does not give a complete picture of the performance of an entity. Financial performance is the result of other factors such as market share and customer satisfaction. Understanding the performance of an entity requires an understanding of the underlying factors which drive that performance. The critical non-financial performance factors must also be assessed, because they determine the size of profits that a company will make in the longer-term. Therefore targets must be established for non-financial aspects of performance, and performance should be measured against those targets.

Non-financial performance indicators (NFPIs) are measurements of performance that are not financial or monetary. Whereas financial performance indicators are quantitative, non-financial performance indicators may be either:

- quantitative indicators, i.e. measured numerically; or
- qualitative indicators, i.e. not measured numerically.

Where possible, it is usually preferable to use quantitative measures of performance, because these make comparisons easier. For example, customer satisfaction is a non-financial aspect of performance, and could be measured in qualitative terms – i.e. is customer satisfaction improving or getting worse? However it might be possible to measure customer satisfaction quantitatively, by asking customers to provide feedback and satisfaction ratings for the products or services they have bought. Satisfaction ratings, say on a scale of 1 to 10, turn a qualitative aspect of performance into one that can be measure numerically.

Variability in the circumstances of different businesses

With financial performance measurement, there are a limited number of financial performance indicators that are used and applied to all types of business. For example, the ratios discussed in the previous section can be used to measure the performance of many different types of company (though interpretation should be carried out in the light of knowledge of the relevant business sector).

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.

Also, non-financial performance indicators might differ between companies within the same industry. This is because the companies might operate on different business models or might be trying to achieve different objectives or might simply have a different view of what is important to the success of their business.

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.

3.2 Non-financial aspects of performance

For the purpose of assessing the performance of the entity as a whole, it is necessary to identify which aspects of non-financial performance are the most important in terms of the organisation's objectives. The problem is to decide which aspects of performance are critically important. An organisation might identify a number of critical aspects of performance across in different departments within the business.

The whole process would involve:

- Identification of objective
- Identification of the critical aspects of performance necessary to achieve the objective
- Setting targets to drive behaviour towards addressing these critical aspects of performance
- Measuring actual performance so that it can be compared to the desired level of performance
- Communicating results to managers of responsibility centres.

Identifying performance indicators

An organisation would need to carry out some form of analysis to identify suitable non-financial performance indicators

Example: Identifying NFPIs for a railway company.

Objective	To increase passenger revenue by improving the utilisation of each train
How will we do this?	By attracting more passengers
How?	By giving them what they value
What do they value?	Trains being on time
	Cleanliness and comfort

Possible NFPIs

Overall	Percentage capacity utilisation
	Percentage change in number of passenger journeys
Trains being on time	Percentage of trains that arrive late
	Number of cancellations
Cleanliness and comfort	Level of customer satisfaction (from surveys)

For each of the NFPIs identified above the company would need to establish suitable targets, systems for measuring the performance and systems for communicating results to managers.

3.3 Common areas in which companies adopt NFPIs

Many companies identify non-financial performance indicators in the following areas:

- human resources;
- customer satisfaction; and
- quality.

In all cases suitable indicators and associated targets would be established as a result of analysis similar to that illustrated above.

Human resources

A motivated and well-trained workforce of adequate size is often vital to an organisation achieving its objectives.

Possible NFPIs include the following

- labour productivity: output produced per man per hour; or average time to produce a unit of output; or number of customer calls handled per day
- labour turnover rate;
- training days per year;

- absenteeism rates (e.g sick days) often used as a measure of staff morale;
- average hours worked;
- idle time;
- proportion of billable hours;
- head count by grade of labour.

Customer satisfaction

It is customers that ultimately determine the level of profits. Companies often analyse what is important to their customers and structure their marketing offering in line with this.

Measures of customer satisfaction might include:

- percentages of new and returning customers;
- percentage of subscribers renewing their annual subscription;
- results of customer satisfaction surveys;
- number of complaints;
- speed of complaint resolution;
- subsequent sales to customers who registered a complaint previously.

Quality

Quality is linked closely to customer satisfaction. Resolving quality issues has a direct cost (e.g. the cost of replacing an item) and indirect costs (e.g. lost goodwill leading to future lost sales).

Possible quality measures include:

- proportion of re-worked items during production;
- proportion of returns;
- proportion of fails;
- number of successful inspections.

3.4 NFPIs for departments or functions

Performance targets can be set for an entity's departments or in respect of its functions.

Possible non-financial performance indicators might be as follows for different departments:

- **Sales and customer service**
  - calls per hour
  - conversion rates of calls to orders
  - proportion of returning customers
  - proportion of 'very satisfied' customers
  - average waiting time

- number of advertising campaigns run

❑ **Online sales**

- Number of visits to website
- Conversion rates (number of sales as a percentage of the number of visits)
- Number of return visits
- Number of sales to returning customers
- Customer satisfaction (number of return visits/number of complaints)
- Website down time
- Delivery times (time between an order being placed and filled)

❑ **Inventory control**

- average inventory holding
- proportion of wastage
- number of stock outs
- number of returns to suppliers

❑ **Sustainability/environmental measures**

- proportion of components sourced from 'green materials';
- annual percentage reduction in CO_2 emissions;
- proportion of packaging that is recyclable.

❑ **Research and development**

- number of new invention ideas
- conversion rate of invention ideas to production

Practice question **1**

Suggest possible performance measures for a health and safety function in a company.

3.5 NFPIs in different types of industry

Key measures of non-financial performance vary between different types of business and depend on the nature of the business. It is impossible to provide examples for all industries, but the following are some possible examples of NFPIs that might be important in certain industries.

❑ **Airlines**

- average utilisation rates (i.e. percentage of aircraft occupied);
- average non-availability;
- planes - proportion of time in the air;
- average turnaround time for when plane is on the ground.

- **Manufacturing operations**
  - average build time
  - average production line down-time
  - capacity utilisation
- **Hotels**
  - occupancy rates for rooms; customer satisfaction measures.

3.6 Analysing NFPIs

Our earlier guidance about measuring and assessing performance 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?

Practice question **2**

The following results relate to a company that makes and sells electric appliances to retailers.

Comment on the following results:

	2017	2018
Unit sales	28,000	30,000
On time delivery	95%	80%
Sales returns	2%	6%

3.7 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 retail company may have a network of retail stores. The best-performing stores or departments within stores 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.
- **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 may 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.

4 LONGER-TERM VIEWS OFPERFORMANCE

Section overview

- Short-termism in performance measurement
- Performance and sustainability
- Stakeholder-based measures of performance: social and environmental performance

4.1 Short-termism in performance measurement

Performance management systems are often used as a basis for rewarding managers for successful performance. For example, a manager may be given an annual bonus for keeping departmental costs below budget, or a sales manager may be rewarded if the sales and marketing department achieve sales in excess of the budget target.

Bonus systems can encourage short-termism. Short-termism means taking measures to improve performance in the short-term, even though they are either misleading or harmful to the business in the longer term. Short-termism can take a variety of forms. Here are just a few examples.

- A departmental manager is paid a bonus for keeping departmental costs within budget. As a result, the manager decides to defer the purchase of new equipment that would eventually improve output in the department. The reason for deferring the expenditure is to avoid the higher depreciation cost of a new item of equipment, so that departmental costs will not exceed the budget.
- Members of a management team are paid bonuses on the basis of sales revenue obtained in the year. Near the end of the year, actual sales are below budget. Management therefore decide to offer to sell a substantial quantity of product to a customer at a heavily discounted price, even though the sale would be loss-making, in order to meet budget sales targets and obtain their bonus.
- Managers might also manipulate financial results, such as treating expenditures as a long-term asset, or moving revenues from one accounting period to the next.

Short-termism can be harmful to a company, and also misleading. Managers should be encouraged to make decisions that are in the longer-term interests of their organisation, instead of focusing on performance in the short term. An appropriate way of doing this might be for the organisation's senior management to:

- establish performance targets that are linked to the long-term success of the organisation, such as growth in profits over several years, or sales revenues from new and innovative products;
- establish a reward scheme that rewards managers for achieving these long-term targets rather than (or as well as) short-term targets for performance.

4.2 Performance and sustainability

To succeed over the long term, a business must be sustainable. It needs to remain profitable, but to do this it also needs to consider the non-financial aspects of a sustainable business. Sustainability has been defined in terms of setting performance objectives for three areas or aspects of performance:

- economic performance/ financial performance
- performance relating to the environment
- social aspects of performance.

Economic, social and environmental performance are known as the 'three pillars of sustainability'. They are also known as the three Ps (a phrase coined by John Elkington in 1994):

- **People** refers to fair and beneficial business practices for labour (employees), the community and region in which a corporation conducts its business, and the organisation's customers.
- **Planet** (natural capital) refers to sustainable ('green') environmental practices so environmental indicators might include measurements relating to improving energy efficiency; minimising pollution; using renewable materials or sources of energy and avoiding the use of non-renewable items; and minimising waste, for example by recycling materials;
- **Profit** is the economic value created by the organisation after deducting the cost of all inputs, including the cost of the capital tied up. It is the real economic impact the organisation has on its economic environment.

Arguably, a business will not survive over the long term unless it gives due consideration to people and planet, as well as to profit.

4.3 Stakeholder-based measures of performance: social and environmental performance

Definitions: Stakeholder

This is a person, group or organisation that has an interest in an entity.

Anybody who can affect or is affected by an organisation, strategy or project is a stakeholder.

The primary stakeholders in a typical company are its owners, employees, customers and suppliers. However, increasing globalisation, greater environmental and social awareness, and more efficient communication, have resulted in a wider and deeper understanding of the impact that organisations have on society and on the environment. In consequence many organisations take a view of stakeholders that includes other groups in addition to these including the community at large.

There is an increasing understanding that although companies increase economic wealth through growth and the search for profit maximisation, society may well be getting poorer because of the damage that economic activity is having on the environment and society.

A successful business now must not only be financially secure but it must minimise its negative environmental impacts and must meet the expectations of society.

As companies have become increasingly aware of environmental issues, and have started to accept that economic growth might not be sustainable, they have become more interested in measuring sustainability and environmental impact.

Public companies report their financial performance in their published annual financial statements, but many companies also provide information about social and environmental goals and performance, in a strategic report or a sustainability report (or corporate social responsibility report).

Triple bottom line reporting

Performance relating to sustainability may be presented in a triple bottom line report. In traditional financial reporting the bottom line refers to either the profit or loss, which is presented at the very bottom line on in a statement of profit or loss.

Environmentalists and economists have argued that the traditional bottom line does not include the full costs of the business.

Example: Full cost of operation

A company runs a gold mine at a profit.

The operation of the mine has caused significant pollution of the local water supply leading to death and illness among the local population and livestock.

The financial statements bottom line only shows the profit but not these other costs to society.

The triple bottom line adds two more bottom lines. These are social and environmental (ecological) concerns. Triple bottom line (abbreviated as TBL or 3BL) incorporates the notion of sustainability into business decisions.

TBL is an accounting framework with three dimensions, social, environmental (or ecological) and economic (financial). Many organisations have adopted the TBL framework to evaluate their performance in a broader context.

Measures of social and environmental performance

Measures of profitability are similar for all for-profit businesses. However, measures of social and environmental performance may differ widely between companies, because of their size and the nature of their business operations.

One major global company using triple bottom line reporting reported its environmental performance in terms of:

- global energy use, measured in thousands of GWh (giga watt hours)
- global carbon dioxide emissions, measured in metric tonnes
- production of non-recycled waste, measured in metric tonnes

Emissions of other polluting cases can be converted into a ‘carbon dioxide equivalent’, so that the total quantities of polluting emissions by a company can be expressed in a common measure – carbon dioxide. Total emissions of carbon dioxide equivalents by a company are commonly known as the company's 'carbon footprint'.

The same global company reported, as social indicators:

- its donations to communities and sponsorships;
- diversity: the percentage of its employees who were female and the percentage who came from minority groups;
- the number of discrimination charges brought against the company during the year;
- employee satisfaction, based on a census of employee opinion; and
- the recordable injury rate per 1,000 employees.

Some companies publish targets for improvements in the social or environmental aspects of their operations. For example, some global packaging and bottling companies now have targets for the replacement of non-recyclable plastic materials with recyclable or biodegradable materials.

A system for social and environmental reporting

Traditional performance measures are directed primarily at the owners and those who act on their behalf (the management) with most companies using performance measurement systems that are extensions of their financial reporting systems.

Such traditional accounting systems do not provide information which could be used to explain the company's performance in terms of environmental and social impacts. Performance measurement systems must be designed to do this.

In order for a company to design a suitable performance reporting system it must do the following:

- identify its stakeholders;
- find out what aspects of the company's performance are important to each stakeholder group;
- design performance metrics to show the company's performance in each area of interest;
- set targets for each metric and communicate these to the stakeholder;
- design information systems that integrate data collection and information processing so that performance can be measured against these metrics; and
- introduce a transparent system of reporting to stakeholder groups.

Triple bottom line reporting is a framework that can be used to inform this process.

5 THE BALANCED SCORECARD APPROACH

Section overview

- The concept of the balanced scorecard
- The balanced scorecard: four perspectives of performance
- Using the balanced scorecard
- Conflicting targets for the four perspectives

5.1 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.

5.2 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 the most important issues are. 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.

Kaplan and Norton argued that although the main objectives of a business are financial, it is essential for long-term success that the organisation should be able to meet the needs of its customers (the customer perspective). In order to satisfy customers, it must have internal processes that are efficient and effective in delivering the goods or services that customers need (the internal perspective). In order to have effective and efficient internal processes, an organisation needs people with knowledge and skills, as well as a capacity to continue innovating (the innovation and learning perspective).

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.

5.3 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. The list is illustrative only, and organisations will use balanced scorecard measures that are appropriate for their business.

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.

5.4 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.

6 FITZGERALD AND MOON BUILDING BLOCK MODEL

Section overview

- The characteristics of services and service industries
- Controllable performance in service industries
- Fitzgerald and Moon: Performance measurement in service industries
- Applying the Fitzgerald and Moon framework

6.1 The characteristics of services and service industries

Many organisations provide services rather than products. There are many examples of service industries: hotels, entertainment, the holiday and travel industries, professional services, banking, recruitment services, 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 the service ('consumption' by the customer) happen at the same time. With production, the product is sold to the customer after it has been manufactured.
- **Perishability**. It is impossible to store a service for future consumption: unlike manufacturing and retailing, there is no stock or 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. Each provision of the service is different. 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. Similarly, a call centre operator answering telephone calls from customers will be unable to deal with each call in exactly the same way.
- **Intangibility**. With a service, there are many intangible elements of service that the customer is given, and that individual customers might value. For example, a high quality of service in a restaurant is often intangible, but it is 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 Controllable performance in service industries

A starting point for analysing performance measurement in service industries is that companies in a service industry should be able to link their competitive strategy to their operations, to make sure that the services that they are providing will enable the company to achieve its strategic objectives. Performance management systems have an important role, because they can:

- show how well or how badly the organisation has performed in achieving its strategic objectives, and
- identify where improvements are needed.

Performance management systems have been developed in many organisations that:

- link performance measures to objectives
- include external as well as internal measures of performance
- include non-financial as well as financial performance indicators
- recognise that a compromise is often necessary between different performance targets, such as targets for service quality and targets for the cost or the speed of providing the service.

The performance indicators that are used can vary widely between different service industries, and there is no standard set of performance measurements that apply to all services.

However, a framework for analysing performance management systems in service industries was provided by Fitzgerald and Moon.

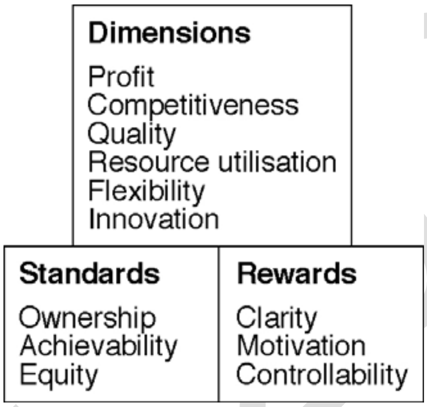
6.3 Fitzgerald and Moon: performance measurement in service industries

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
- Rewards.

These are shown in the following diagram.

Illustration: Building blocks for performance measurement systems



Fitzgerald and Moon 1996

Dimensions of performance

Dimensions of performance are the aspects of performance that are measured. A critical question is: What are the dimensions of performance that should be measured in order to assess performance?

Research by Fitzgerald and others (1993) and by Fitzgerald and Moon (1996) concluded that there are six dimensions of performance measurement that link performance to corporate strategy. These are:

- profit (financial performance)
- competitiveness
- quality
- resource utilisation
- flexibility
- innovation.

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/sales margins 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 Possibly market share, although this may be difficult to measure
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 Possibly the speed in responding to customers' requests
Resource utilisation	Efficiency/productivity measures Utilisation rates: percentage of available time utilised in 'productive' activities
Innovation	Number of new services offered Percentage of 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.

Performance: results of past actions

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.

Determinants of future performance

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;
- resource utilisation;
- flexibility; and
- 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.

Standards

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.

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 standards have 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.

Standards should also be fair for everyone in all business units, and should not be easier to achieve for some managers than others. To achieve fairness or equity, when local conditions for the individual business units can vary, it is often necessary to assess performance by relying on subjective judgement rather than objective financial measurements.

Rewards

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.

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 and Moon, 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 a 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.

6.4 Applying the Fitzgerald and Moon framework

The actual measures of performance used by companies in service industries will vary according to the nature of the service. Fitzgerald and Moon used case studies, however, to show how their framework can be used to assess performance management systems.

One successful (and large) organisation reported as a case study was a food retailing business with a large number of stores. Applying the Fitzgerald and Moon framework, the performance management system was analysed as follows:

Dimensions of performance

The company used four of the six dimensions of performance to assess the performance of individual stores and the performance of each region.

Dimension of performance	Measures used	Comments
Financial performance	Profit by store and by region.	Profit is seen as a very important measure of performance. The performance of each store and region is publicised within the company, by means of 'league tables', so that each store manager knows how his store has performed in comparison with others.
Competitiveness	Market share (at company level). Prices of competitors for each local store. Observation.	The company places great importance on monitoring the prices charged by competitors. Prices are monitored for each store, at the 'local' level. Market share is assessed from published market share statistics. Managers of local stores may visit the stores of competitors to see how full their car park is, and compare this with the number of cars in the car park of their own store.
Quality of service on specific transactions	Letters and other messages from customers. Observation	The quality of service is monitored by 'mystery shoppers' – individuals hired by the company to visit stores disguised as customers, to observe the quality of service provided.
Quality of service overall	A range of measures for each store and warehouse/depot	A number of different aspects of service quality are monitored and measured, and a performance league table for stores and warehouses is published internally.
Flexibility	No formal performance measurement	However, managers are aware of the need for flexibility. For example, when there are staff shortages due to absenteeism, store managers will telephone part-time staff and ask them to fill the vacancies at short notice.

Dimension of performance	Measures used	Comments
Resource utilisation	Sales per square metre. Wastage rates	
Innovation	No formal performance measurement	The need to innovate continually is recognised, however, and innovation is discussed regularly at business planning meetings.

Standards of performance

The research found a significant difference between the level of ownership for:

- profit; and
- quality of service.

Managers participated in the process of setting profit targets for their store or region, through the formal business planning process. However, standards for quality of service were imposed by central management (head office). The view of senior management was that quality standards must be the same at every store in the country; therefore standards must be decided at head office for the company as a whole.

'Standards' of performance were assessed for both profitability and quality of service.

Standard	Comment
Profit	
Ownership	Managers were involved in setting profit targets, as part of the discussions with head office about annual targets and business planning.
Achievability	The standards/targets were considered achievable by the managers responsible for achieving them.
Equity	In setting profit targets for each store, allowance was made for the effect of competition from local competitors to each individual store.
Quality of service	
Ownership	Standards were imposed by head office.
Achievability	However, they were seen as achievable. An aspect of standard-setting was the use of internal benchmarks, and comparisons of quality standards at different stores within the company.
Equity	No allowances were made for different local conditions. All stores throughout the country were expected to achieve the same standards.

Reward mechanisms for achieving standards

The three elements of reward systems within the Fitzgerald and Moon framework are:

- ❑ clarity of goals and targets;
- ❑ how managers are motivated to achieve targets; and
- ❑ whether there are any problems about shared costs and controllability of costs

The research findings were as follows:

Element	Comments
Clarity of goals	Managers were aware of company strategy, and clearly understood how their performance would contribute to the achievement of strategic objectives.
Motivation:	
short-term financial motivation	Store managers received a bonus for achieving targets. In addition, there were 'team' bonus payments.
non-financial aspects	Managers had pride in their position in the league tables of stores, and were motivated to improve or maintain their position in the league.
Controllability	There were no problems with controllability of costs or allocation of shared costs.

Conclusions

Conclusions drawn from this case study, based on the Fitzgerald and Moon framework, were as follows:

- ❑ The company was highly successful.
- ❑ It had a clear statement of strategy that was well understood by management in regions and local stores.
- ❑ Performance measures were consistent with that strategy.
- ❑ Performance measures were reported regularly, covering a range of financial and non-financial aspects of performance.
- ❑ The performance measurements were clearly defined and communicated to employees at all levels in the company, and there were regular reports on actual achievements.
- ❑ The driving force for performance targets was the satisfaction of customers' needs.
- ❑ The performance measurement system was reinforced by a rewards system to motivate managers and by a pride in performance.

7 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the nature of performance and non-performance indicators in a performance management system
- Measure and use a range of financial performance indicators
- Measure and use a range of non-financial performance indicators
- Explain the nature of short-termism in performance measurement
- Explain the relevance of sustainability measurements (social and environmental measurements) for an assessment of longer-term performance
- Explain the balanced scorecard approach to performance management and apply it in a given scenario
- Explain the Fitzgerald and Moon Building Block model and its application to performance measurement in service industries

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

Possible performance indicators for a health and safety function include (but are not limited to) the following:

a. Number of accidents in period – no injury

b. Number of accidents in period – causing injury

c. Number of fatalities in a period;

d. Number of days since a fatality;

e. Days lost through work related illness

f. Number of days spent on health and safety training for health and safety officers.

g. Number of days spent on health and safety training for employees

Solution **2**

Unit sales

The number of appliances old has increased by 7.1% (28,000 to 30,000).

At first sight this is very pleasing. However, there is no information about the margins in respect of these sales. If the sales have increased as a result of price reductions there might be a negative impact on the profitability of the company.

Also there is no information about the size of the market. If the market has increased by 10% (say) then the company has lost market share and the performance which looks favourable may not actually be so.

On-time delivery

There is a worrying deterioration of the percentage of deliveries made on time.

This could lead to increase costs if the customer contracts include service level agreements calling for compensation for late delivery.

There is also a possibility of loss of custom in the future.

Sales return

There is a very worrying increase in the number of units returned. This might be due to the company sending incorrect order or selling defective unit. Either of these could be explained by staff being unable to cope with the increased activity levels. Correction of mistakes has an associated cost including the possible loss of future sales to customers who are dissatisfied.

The increase could also be due to the company allowing its customers to buy goods on a sale or return basis. This makes it more difficult to interpret the increase in sales as still more goods might be returned in the future

The increased sales seem to have caused other areas of performance to suffer.

t

Skills level
Performance management

CHAPTER 10

Other aspects of performance measurement

Contents

INTRODUCTION

Aim

The previous chapter considered performance management and the use of performance indicators from the perspective of a for-profit commercial business, and mostly from a short-term perspective. Many organisations do not have a profit perspective and are not-for-profit government departments and charities being examples – although financial performance is important for them. Candidates are expected to be capable of discussing the problems of performance measurement in not-for-profit organisations and demonstrate the application of value for money criteria. They should also be capable of considering strategic aspects of performance measurement in for-profit organisations, and in particular performance measures relating to profitability, liquidity and solvency.

Detailed syllabus

The detailed syllabus includes the following:

C	**Performance measurement and control**		
	2	**Performance analysis in not-for-profit organisations**	
		A	Discuss the problems of having non-quantifiable objectives in performance management.
		B	Explain how performance may be measured in the not-for-profit organisations.
		C	Discuss the problems of having multiple objectives.
		D	Demonstrate value for money (VFM) as a public sector objective.

E	**Strategic performance measurement**		
	2	Analyse and evaluate suitable performance measures for:	
		A	Profitability (GP, ROCE, ROI, EPS, EBITDA, etc.);
		B	Liquidity; and
		C	Solvency.

Exam context

This chapter explains the nature of performance measurement in not-for-profit organisations, and also the strategic aspects of performance measurement.

By the end of this chapter, you should be able to:

- Explain how performance might be measured in not-for-profit organisations
- Explain the objective of value for money and its application to not-for-profit organisations and the problems of multiple objectives
- Analyse and evaluate the strategic aspects of performance relating to profitability, liquidity and solvency

1 PERFORMANCE ANALYSIS IN NOT-FOR-PROFIT ORGANISATIONS

Section overview

- Problems with having non-quantifiable objectives
- Measuring performance in not-for-profit organisations
- Problems with multiple objectives

1.1 Problems with having non-quantifiable objectives

Not-for-profit organisations exist to provide benefits to a targeted group of people or to society as a whole. Government-owned institutions use taxpayers' money to provide services to the public, such as health services, education, policing, the criminal courts system and so on. Some government departments perform administrative tasks on behalf of the government, such as the tax department. Although they must operate within the constraints of the money (budget) available to them, the main objectives of government and state-owned organisations are non-financial.

Similarly, the objectives of charities are to provide assistance to a targeted group, such as aid for victims of war or natural disasters, assistance for people with certain illnesses or disabilities, assistance for local communities, funding research into disease, care for old people, and so on. They must operate within the constraints of the financial contributions they receive, from the government and individual donations, but their prime objective is non-financial.

A problem with having a non-financial objective is that they can be difficult to quantify. How does a health service quantify the provision of its services; how is the provision of education or policing measured? How is the objective of helping victims of tsunamis or earthquakes measured?

The answer is that these overriding non-financial objectives cannot be properly quantified. Whereas for-profit companies have quantifiable financial objectives, most not-for-profit organisations have non-quantifiable broad objectives.

1.2 Measuring performance in not-for-profit organisations

Performance management systems rely on the use of quantifiable performance indicators. This is true for not-for-profit organisations as well as for commercial companies.

Not-for-profit organisations can set financial objectives, although these are not their main objective. For example, a government department can set an objective of operating within its allocated budget limits. A charity can set an objective of raising the amount of money it receives from donations.

However, for a performance measurement system to operate effectively, not-for-profit organisations need quantifiable objectives that relate to their main objective. They do this by identifying a number of targets which are considered 'key' to successful performance, and measure performance by comparing actual results with these key targets.

Example: Quantifiable objectives

A health service may set targets for the numbers of patients treated each year in hospitals or in doctors' surgeries, the average length of stay of patients in hospitals, targets for reducing the numbers of people suffering from specific diseases or ailments, and so on.

Similarly a police force may set targets for reductions in the number of murders, reductions in the number of burglaries, an increase in successful prosecutions of criminals, and so on.

A state-run education system can set targets for schools for the number of children achieving 'A grades' in their examinations at various ages, and targets for the proportion of children moving on to university or technical college after school.

In other words, not-for-profit organisations can assess performance by comparing actual results against a range of quantifiable targets.

1.3 Problems with multiple objectives

A problem with having multiple objectives, without an overall quantifiable main objective, is that organisations may perform well when measured against some of their performance targets, but may perform badly in relation to other targets. When this happens, how do we decide whether the organisation has performed successfully or not?

Example: Multiple objectives

A national health service may succeed in treating a larger number of patients in hospital, but average waiting times for hospital treatment might get longer.

A police force may achieve its target of reducing the number of murders each year by 10%, but fail to achieve its target of reducing burglaries by 5% - and the number of burglaries may even have increased.

In the schools system, targets for examination results may be achieved for 11-year old children, but exam results may be poor for 16-year olds.

Problems with multiple performance objectives are that:

- It is difficult to assess overall performance when some key targets are met but others are not
- The key targets that are selected may not properly represent all the not-for-profit objectives of the organisation: for practical reasons the number of performance targets must be limited to a manageable number.

2 VALUE FOR MONEY

Section overview

- The nature of value for money
- VFM as a public sector objective
- Quantitative measures of efficiency
- Quantitative measures of effectiveness

2.1 The nature of value for money

The value for money approach to measuring performance in non-for-profit organisations is based on the idea that these organisations must work within financial constraints. Government departments must operate within budget limits. Charities must operate within spending limits set by the amount of donations they receive.

Not-for-profit organisations should therefore aim to make the best use of the money available to them, and create 'value' in what they do. Making the best use of money is described as achieving value for money or VFM.

Value for money is defined as the utility derived from an amount of money spent.

There are three aspects to achieving value for money, often referred to as the '3Es':

- ❑ economy
- ❑ efficiency
- ❑ effectiveness.

The concept of VFM can also be applied in commercial for-profit businesses, but it is more commonly used in performance measurement systems of not-for-profit organisations.

Economy

Economy means keeping spending within limits, and avoiding wasteful spending. It can also mean achieving the results but for less cost. 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%.

2.2 VFM as a public sector objective

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.

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: Value for money (3 Es)

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.

A problem with VFM as a performance measurement system is that it is not easy to apply VFM to **planning and** setting performance targets. An organisation can assess retrospectively whether or not a particular aspect of operations has achieved value for money**, but it is not so easy to plan in advance just how value for money will be achieved.**

Example: Value for money audit

A local authority sets up a project aimed at encouraging more young people in the area into employment, with the objective of increasing the number of 16-24 year olds in the local area who are in employment by 10% over three years.

The project managers were very driven to achieve this target and the project ultimately increased employment rates of this demographic by 12% over the period. However, the enthusiasm with which meeting the set target was embraced did result in higher than expected costs and there was an overspend of 8% on the budget for the project.

The overspend prompted a value for money audit to be carried out. A key finding from this was that the project was marginally less expensive, on an outcome by outcome basis, than similar campaigns run by other local authorities in the country.

Required

Determine whether or not you consider the local authority employment project to have delivered value for money by making reference to the economy, efficiency and effectiveness of the project.

Answer

Economy: For the project to deliver economy it should control its expenditure and make the best use of its resources. The overspend on the budget shows that the cost control could have been better and indicates that economy may not have been achieved for this project.

Efficiency: The project will be efficient if it has made full use of its resources in the best possible way to meet the objectives. The comparative data indicates that, on an outcome by outcome basis, the project cost slightly less than similar projects carried out by other local authorities. This suggests that the project was efficient.

Effectiveness: The project will be considered effective if it met its objective of increasing employment in the target demographic by 10% over the period. This target was exceeded and an increase in 12% was observed. This indicates that the project was effective.

Overall: the project was both efficient and effective. It does not appear that it was economic which implies that overall value for money may not have been achieved. However, it is possible that the cost projections were too ambitious. If this was the case the project may have delivered value for money overall. Further investigation will be needed.

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: Quantitative measures of efficiency

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

$$35/40 \times 100\% = 87.5\% \text{ efficiency}$$

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

$$1{,}000/900 \times 100\% = 111.1\% \text{ efficiency}$$

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

$$27/26.2 \times 100\% = 103.05\% \text{ efficiency.}$$

2.4 Quantitative measures of effectiveness

Effectiveness relates what has been achieved to the intended objectives for achievement.

Example: Quantitative measure of effectiveness

The operating theatre in a hospital may have a maximum capacity of 40 operations per day and the average utilisation of this capacity may be 87.5%. This is a measure of efficiency in the use of the hospital operating theatre. But the aim of operations in hospitals is to treat patients successfully. The target may be for 95% of operations to be successful, but the actual success rate (measured perhaps by whether patients need further treatment after their operation) may be just 90%. This would be a measure of effectiveness in obtaining value for money.

3 STRATEGIC PERFORMANCE MEASUREMENT

Section overview

- The primary financial performance objective
- Primary measures of business growth
- Measuring financial risk: liquidity and gearing
- Measuring financial risk: solvency

3.1 The primary financial performance objective

For companies, the primary strategic performance objective should relate to the benefits of their owners, the shareholders. The aim should be to provide benefits to shareholders over the long term, in the form of dividends from profits and share price growth.

Share price growth comes mainly from growth in the business and earnings per share. However, growth should not be achieved if it exposes the company to excessive risks. The primary objective of financial performance targets should therefore be consistent with the long-term objectives of both:

- business growth; and
- survival.

Strategically, companies should seek to balance risk and return.

3.2 Primary measures of business growth

There are several measures of financial performance that could be used to assess success in achieving corporate objectives.

- It is inappropriate to use targets for share price growth and dividend growth as formal planning targets and measures of actual performance. Share prices can be volatile and affected by stock market conditions outside the control of a company's management. Dividend policy, on the other hand, is under the control of the board of directors, but can be manipulated. Dividend payments do not have to move in line with changes in profitability or longer-term financial expectations of profit.
- It is therefore more appropriate to measure financial performance in terms of conditions that should lead to share price growth and dividend growth in the future.

To assess strategic performance, financial measurements should consider the longer term, and prospects for the future. Typically, this means considering changes in profits over the past few years, and projections of profitability in the future.

The same measurements are used to assess short-term performance, but at a strategic level, the longer-term view is considered, not simply the result for the previous financial year.

Financial measures used to measure historical performance, and assess whether a company appears to be achieving its corporate objectives, may be:

- return on capital employed (ROCE)
- earnings per share (EPS) and growth in earnings per share
- earnings before interest, tax, depreciation and amortisation (EBITDA)
- for investment centres, return on investment (ROI) or residual income

None of these performance measures is ideal for assessing performance and progress towards achieving the corporate objective, because none of them on their own measure the success of the company in achieving a return that is consistent with the risks to which the company and its owners are exposed.

- **Return on capital employed (ROCE)** is a useful measure of performance, because it relates the amount of profit earned to the amount of capital employed in the business. However, the measurement of ROCE depends on accounting conventions for the measurement of profit and capital employed. Measure of profit in financial statements is not a reliable guide to financial returns on investment.
- **Earnings per share (EPS) and EPS growth** are also commonly used to assess performance. On the assumption that in the long term, the ratio of the share price to EPS (the price/earnings ratio or P/E ratio) remains fairly constant, growth in EPS should result in a higher share price. However, the P/E ratio does not necessarily remain constant over the long term and could change if the perception of investment risk in the company changed.

  Some 'tech' companies, particularly in the USA, have achieved growth in their share price without yet making any profits. Investors have been willing to put money into loss-making companies in the expectation that future returns will eventually be huge. Measurements of EPS (or loss per share) are inappropriate in these cases.
- **EBITDA** (Earnings before interest tax depreciation and amortisation). EBITDA is a useful measure of performance only if it is assumed that management have no control over interest costs or depreciation and amortisation charges. This may be true for profit centre management, but is unlikely to be the case when managers have control over investment and financing decisions. EBITDA is a useful approximation of cash flow from operations before interest and tax, and can be a useful measurement of financial performance for this reason. (Note: If you are not sure about this, think about the calculation of operational cash flows in a statement of cash flows, using the indirect method.)

The benefits and limitations of **ROI** and **residual income** are considered in chapter 12.

3.3 Measuring financial risk: liquidity and gearing

A strategic objective of a company should be survival, as well as to achieve growth and financial returns. It is therefore appropriate to assess and measure financial risk. Measures of financial risk include:

- ❑ **liquidity** risk, measured by ratios such as the current ratio or quick ratio, or by cash flow analysis
- ❑ **gearing** or debt/equity ratios.

Liquidity can be important. Liquidity means having cash or access to cash to make payments when these are due. For example, a company must have cash to pay salaries and wages of its employees, and to pay suppliers and other creditors. In some cases, profitable companies might become insolvent because they cannot pay their debts.

A lack of liquidity also restricts flexibility of action. A company that is short of cash is often unable to take advantage of new opportunities that might arise, because they do not have the money to spend.

From a strategic perspective, liquidity can be assessed by cash flows. Cash flows as reported in a statement of cash flows show where a company is obtaining its cash and how it is using and spending its cash. From a strategic perspective, cash flows must be sustainable.

For example, a company should be obtaining much of its cash from profitable operations. If it is loss-making, and obtaining cash by borrowing or from new share issues, there may be questions about the long-term liquidity of the company.

Gearing and debt levels can also be important. Gearing or debt levels can be measured as the ratio of debt to equity, or the ratio of debt to total assets. Highly-geared companies are exposed to the risk of a big fall in earnings per share whenever there is a fall in their operating profits. When they borrow at variable rates of interest, an increase in interest rates will also reduce profitability.

3.4 Measuring financial risk: solvency

Solvency can be defined as an ability to pay debts when they fall due. Insolvency is the opposite – an inability to pay debts when they fall due.

Companies may have some short-term problems with payments of debt, and can overcome the problem by deferring payments for a short time (obtaining more credit).

However from a strategic perspective, solvency is a long-term consideration. A company must be able to pay its debts. If it cannot, there is a high risk that major creditors will take legal initiatives to have the company declared insolvent.

Solvency for a commercial company depends on a combination of:

- ❑ **Profitability**: companies may make losses in some years, but from a strategic perspective, it needs to be profitable over the longer term. Companies cannot remain loss-making for ever.
- ❑ **Liquidity**: companies need cash to operate. Cash flow and profits are not the same thing. A profitable company may run out of cash. A loss-making company can raise cash by borrowing. However, over the long term, companies must obtain cash to meet their expenditures.

- **Debt**: companies are potentially at risk if they borrow too much. Interest rates have been low throughout the 2010s, following the financial crisis of 2008 and low-interest policies of central banks (particularly in the USA and Europe). In an environment of low interest rates, many companies have borrowed large amounts of money. An insolvency risk arises if the company would be unable to meet its debt payment obligations (interest payments and capital repayments) if interest rates were to rise.

4 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain how performance might be measured in not-for-profit organisations
- Explain the objective of value for money and its application to not-for-profit organisations and the problems of multiple objectives
- Analyse and evaluate the strategic aspects of performance relating to profitability, liquidity and solvency

Skills level
Performance management

CHAPTER 11

Transfer pricing

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

C	**Performance measurement and control**		
	3	**Divisional performance and transfer pricing**	
		a	Discuss the various methods of setting transfer prices and evaluate the suitability of each method.
		b	Determine the optimal transfer price using appropriate models.
		c	Explain the benefits and limitations of transfer pricing methods.
		d	Demonstrate and explain the impact of taxation and repatriation of funds on international transfer pricing.

Exam context

This chapter explains the meaning and importance of transfer pricing and explains and illustrates different transfer pricing techniques.

By the end of this chapter, you should be able to:

- Explain suitable bases for transfer pricing
- Select suitable bases for transfer pricing
- Set optimal transfer prices

1 TRANSFER PRICING: PURPOSE AND OBJECTIVES

Section overview

- Introduction
- Transfers at marginal cost
- Transfers at full cost
- Transfer pricing at cost plus
- Transfer pricing at market price
- The objectives of transfer pricing

1.1 Introduction

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.

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 the 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.

Possible methods include:

- marginal cost;
- full cost;
- cost plus;
- market price

These will be considered in turn.

1.2 Transfers at marginal 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: Transfers at marginal cost

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	1,000	1,000
	₦	₦
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

The budgeted annual profit for each division if the units of component X are transferred from Division A to Division B at marginal cost are as follows.

Example (continued): Transfers at marginal cost (budgeted performance)

	Division A	Division B	Company as a whole
Units produced/sold	1,000	1,000	1,000
	₦	₦	₦
External sales of final product	-	350,000	350,000
Internal transfers (1,000 × ₦70)	70,000	-	0
Total sales	70,000	350,000	350,000
Costs of production			
Internal transfers (1,000 × ₦70)	-	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 the 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 1,100 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.

Example: Transfers at marginal cost with actual sales higher than budget

Following on from the previous example.

	Division A	Division B
Units produced/sold	1,000	1,000
	₦	₦
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

The reported profit if actual sales prices, actual variables costs per unit and total fixed costs were as budgeted, but units sold are 10% more than budget is as follows.

	Division A	Division B	Company as a whole
Units produced/sold	1,100	1,100	1,100
	₦	₦	₦
External sales of final product	-	385,000	385,000
Internal transfers (1,100 × ₦70)	77,000	-	0
Total sales	77,000	385,000	385,000
Costs of production			
Internal transfers (1,100 × ₦70)	-	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

1.3 Transfers at full cost

Transfers at full cost: budgeted performance:

In this example, the full cost per unit produced in Division A is ₦150, with an absorption rate for fixed overheads of ₦80 per unit produced and transferred.

Example: Transfers at full cost

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	1,000	1,000
	₦	₦
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

The budgeted annual profit for each division if the units of component X are transferred from Division A to Division B at full cost are as follows.

	Division A	Division B	Company as a whole
Units produced/sold	1,000	1,000	1,000
	₦	₦	₦
External sales of final product	-	350,000	350,000
Internal transfers (1,000 × ₦150)	150,000	-	0
Total sales	150,000	350,000	350,000
Costs of production			
Internal transfers (1,000 × ₦150)	-	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/(net cost or loss)	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 1,100 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.

Example: Transfers at full cost

Following on from the previous example:

	Division A	Division B
Units produced/sold	1,000	1,000
	₦	₦
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

The reported profit if actual sales prices, actual variables costs per unit and total fixed costs were as budgeted, but units sold are 10% more than budget is as follows.

	Division A	Division B	Company as a whole
Units produced/sold	1,100	1,100	1,100
	₦	₦	₦
External sales of final product	-	385,000	385,000
Internal transfers (1,100 × ₦150)	165,000	-	0
Total sales	165,000	385,000	385,000
Costs of production:			
Internal transfers (1,100 × ₦150)	-	165,000	0
Other variable costs	77,000	33,000	110,000
Fixed costs	80,000	90,000	170,000
Total costs	157,000	288,000	280,000
Profit/(net cost or loss)	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: Transfer pricing at cost plus

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	1,000	1,000
	₦	₦
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

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%, are as follows:

Example (continued): Transfer pricing at cost plus

The full cost per unit produced in Division C is ₦150, and the transfer price (full cost plus 20%) is ₦180.

	Division C	Division D	Company as a whole
Units produced/sold	1,000	1,000	1,000
	₦	₦	₦
External sales of final product	-	350,000	350,000
Internal transfers (1,000 × ₦180)	180,000	-	0
Total sales	180,000	350,000	350,000
Costs of production			
Internal transfers (1,000 × ₦180)	-	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: Transfer pricing at market price

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 ₦160 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	2,000	1,000
	₦	₦
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	220,000	120,000

The budgeted annual profit for each division if the units of component Y are transferred from Division G to Division K at market price are as follows.

	Division G	Division K	Company as a whole
Units produced/sold	2,000	1,000	1,000
	₦	₦	₦
External sales of product Q	-	350,000	350,000
External sales of component P	160,000	-	160,000
Internal transfers (1,000 × ₦160)	160,000	-	0
Total sales	320,000	350,000	510,000
Costs of production			
Internal transfers (1,000 × ₦160)	-	160,000	0
Other variable costs (2,000 × ₦70)	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; and
- 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; and
- 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.

2 PROBLEMS WITH TRANSFER PRICING

Section overview

- 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

2.1 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

In identifying the ideal transfer price, there are three scenarios that need to be considered when handling transfer pricing mechanisms:

a. **When there is no spare capacity-** This simply means that the selling division is operating at full capacity and cannot increase output beyond what is produced and sold. The optimal transfer price here is marginal cost plus opportunity cost of making the transfer.

b. **When there is spare capacity**- This is when the selling division is not operating at full capacity, the transfer price is the marginal cost of producing the transferred item.

c. **When there is limited spare capacity-** This is a variant of (b) above. Under this scenario , the selling division needs to beef up additional product from external suppliers to meet the limited requirements for the buyer. The optimal transfer price is computed in the same mode as (b) above. The transfer price for the units met from the spare capacity is at marginal cost, while that of the remaining is at the opportunity cost based on the purchases from external suppliers

Equally, the following rules should help one to identify the ideal transfer price in other situations:

- **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: Ideal transfer price with no external intermediate market

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	100
Fixed cost	80
Total cost	180
Division B	
Further processing costs	
Variable cost	40
Fixed cost	70
	110
Selling price per unit of product Y	400

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?

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 ₦140 (₦100 + ₦40). The sales price of product Y is ₦400.

The entity therefore makes additional contribution of ₦260 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	400
Variable further processing costs in Division B	40
	360

The opportunity cost of not buying units of component X, ignoring the transfer price, is ₦360 per unit.

Division B should therefore be willing to pay up to ₦360 per unit for component X. Any transfer price below ₦360 but above ₦40 per unit will increase is 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 ₦100. 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 ₦100.

Ideal transfer price

The ideal transfer price is anywhere in the range ₦100 to ₦360. 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: Ideal transfer price with an external intermediate market

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	600
Fixed cost	300
Total cost	900

Division Q uses one unit of component X to make one unit of product Y, which it sells for ₦2,000 after incurring variable further processing costs of ₦250 per unit.

The ideal transfer price or range of transfer prices, if the price of component X in the external intermediate market is ₦1,400 can be found as follows.

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 ₦1,150 (₦2,000 – ₦600 – ₦205).

The additional contribution from making one unit of component X and selling it externally is ₦800 (₦1,400 – ₦600).

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.

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 not more than ₦1,400 when the external market price is ₦1,400.

If the external market price and transfer price are both ₦1,400, Division Q will make an incremental contribution of ₦350 (₦2,000 – ₦1,400 – ₦250) 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.

Example (continued): Ideal transfer price with an external intermediate market

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 ₦1,400	**₦**
Variable cost	600
Opportunity cost of lost external sale (1,400 – 600)	800
Total cost = minimum transfer price	1,400

Example: Ideal transfer price with an external intermediate market

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	600
Fixed cost	300
Total cost	900

Division Q uses one unit of component X to make one unit of product Y, which it sells for ₦2,000 after incurring variable further processing costs of ₦250 per unit.

The ideal transfer price or range of transfer prices, if the price of component X in the external intermediate market is ₦580 can be found as follows.

(Assume that the selling division cannot be closed down).

Example (continued): Ideal transfer price with an external intermediate market

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 ₦1,150 (₦2,000 – ₦600 – ₦250).

When the external market price is ₦580 for component X, Division P would make an incremental loss of ₦20 per unit (₦580 – ₦600)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.

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 not more than₦580.

If the external market price and transfer price are both ₦580, Division Q will make an incremental contribution of ₦1,170 (₦2,000 – ₦580– ₦250) 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 ₦58	**₦**
Variable cost	600
Opportunity cost of lost external sale (580 – 600)	(20)
Total cost = minimum transfer price	580

If the variable cost of making a component is greater than the price on an external market, the company would be better off closing the selling company and buying externally.

Example: Ideal transfer price with an external intermediate market

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	600
Fixed cost	300
Total cost	900

Division Q uses one unit of component X to make one unit of product Y, which it sells for ₦2,000 after incurring variable further processing costs of ₦250 per unit.

The price of component X in the external intermediate market is ₦580.

Contribution made by the company with an without internal transfer is as follows:

	Component X made	
Contribution	**Internally**	**Externally**
	₦	**₦**
Selling price	2,000	2,000
Variable cost of manufacture	600	
Price on external market		580
Further processing cost	250	250
Total cost	850	830
Contribution	1,150	1,170

When the external market price is ₦580 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 ₦580rather than make internally for a marginal cost of ₦600 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.

I some situations there is no ideal transfer price as the company would be better off sourcing the component externally

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.

Division B buys Product Y, which it uses to make an end product which can be sold to earn excellent margins.

The costs and selling prices of Product Y and Product Z are:

	Product Y	Product Z
	₦	₦
Selling price (price on the external market)	150	170
Variable cost of production	100	90
Contribution per unit	50	80

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.

Required

What is the ideal transfer price or range of transfer prices?

Answer

Step 1: What is in the best interests of the company as a whole?

The company would want to maximise contribution.

It 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 ₦150 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	100
Opportunity cost of lost external sale of Product Z (170 – 90)	80
Total cost = minimum transfer price	180

Ideal transfer price/ideal production and selling plan

Division B will not want to pay more than ₦150 for transfers of Product Y; otherwise it will buy Product Y externally.

Division A will want to receive at least ₦180 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 ₦150 and for Division A to make and sell Product Z.

Practice questions **1**

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 ₦700, and the sale price of Product X in the external market is ₦1,000 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 ₦290 per unit of Product Y. The external selling price of Product Y is ₦1,400 per unit.

An external supplier has offered to sell units of Product Y to Division B for ₦1,030 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.

3 TRANSFER PRICING IN PRACTICE

Section overview

- 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 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 managers 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.

4 IMPACT OF TAXATION AND REPATRIATION OF FUNDS

Section overview

- Corporate objectives and the relevance of tax and transfer pricing
- Transfer pricing and tax rules

4.1 Corporate objectives and the relevance of tax and transfer pricing

The corporate objective of a multinational company, as for any other company, is linked to profitability and returns for shareholders. Multinational companies operate in different countries, and are therefore subject to differing tax regulations and systems. MNCs will try to improve earnings for shareholders by minimising their worldwide tax liabilities.

- Multinational companies will seek to invest in countries where the taxation system is more favourable. For example, companies might seek relief from taxation for making capital investments in a country, and will choose one country in preference to another on the basis of the tax advantages offered
- Some MNCs have been accused of using transfer pricing to minimise their tax liabilities. Transfer prices are used to charge for goods and services transferred between companies in the group. Transfer prices can be charged in such a way that:
  - transfers from a subsidiary in a high-tax country to a subsidiary in a low-tax country are fixed at high levels, and
  - low transfer prices are set for transfers from a low-tax to a high-tax country.

In this way, profits in the high-tax subsidiaries are reduced, and more profits are earned in the low-tax countries.

4.2 Transfer pricing and tax rules

Transfer prices are prices charged internally within a group, and have no effect on the total pre-tax profit of the group. Transfer prices are simply a way of sharing the profit between the two companies concerned.

Transfer prices between a company and a foreign subsidiary have implications for taxation, and the aim of a group of companies should be to minimise total tax payable on the group profits. Issues to consider are:

- the rate of taxation on profits in the two countries
- the existence of a double taxation agreement
- the existence of any withholding tax in the country of the foreign subsidiary
- tax rules on transfer pricing.

Tax rates

The rate of taxation on profits will vary between the two countries and two companies concerned. As a general principle, the aim of a group should be to set a transfer price that shares the profits in a way that reduces the profits of the company in the higher-tax country.

For example, suppose that a parent company in country A sells goods to its 100%-owned subsidiary in country B, and the rate of tax is 20% in country A and 30% in country B. The transfer price should be set as high as the tax rules permit, because this will increase profits of the parent company in lower-tax country A and reduce the profits of the subsidiary in higher-tax country B.

Double taxation agreement

There should usually be a double taxation agreement between the two countries. From the point of view of the parent company, this means that:

- If the rate of tax on profits is higher in the country of the foreign subsidiary than in the parent company's country, the subsidiary pays tax in its own country on its profits at the rate applicable in that country. No further tax is payable in the parent company's country on the profits of the foreign subsidiary.
- If the rate of tax on profits is lower in the country of the foreign subsidiary than in the parent company's country, the subsidiary pays tax in its own country on its profits at the rate applicable in that country. However, tax is also payable by the parent company in its own country. The tax payable is the difference between tax on profits at the rate in the parent company and the tax payable by the subsidiary in its own country.

Withholding tax

Withholding tax is additional tax that is 'withheld' when a company pays interest or dividends to a foreign investor. It affects international groups where foreign subsidiaries are located in a country where withholding tax is charged. Payments of interest or dividends by a subsidiary to the parent company will be subject to the withholding tax.

Tax rules on transfer prices

The tax rules in a country are likely to make it difficult for an international group to charge inter-company transfer prices that are significantly different from market prices (where these exist). This is because the tax authorities recognise that transfer prices might be set artificially so as to minimise the total tax burden for the group.

These various tax aspects of transfer pricing are illustrated by the following example.

Example: Transfer pricing at market price

A Nigerian company has recently acquired a foreign subsidiary in another country, Outland.

A part of the operating arrangements of the new group is that the parent company will export a component to the subsidiary, and the subsidiary will use this component to make a product that it will sell in Outland.

LC (local currency) is the currency in Outland.

The following information is available:

Nigerian Company	
Sales (components transferred to Outland)	100,000
Variable cost per unit	₦15
Fixed costs	₦900,000
Tax rate	30%
Outland Company	
Units of product sold (based on components transferred in)	100,000
Sales price per unit	LC 150
Local variable cost per unit (in addition to transfer cost)	LC 40
Fixed costs	LC 600,000
Tax rate	30%

The exchange rate is ₦1 = LC4.

Withholding tax of 10% is charged on all remittances of interest and dividends from Outland.

The Nigerian parent company intends to remit all available profits from Outland to Nigeria.

There is a double taxation agreement between Nigeria and Outland. Tax on income and distributions in one country may be credited against a tax liability on the same income in the other country.

Tax on profits in Outland will be 25%, but there will be an additional withholding tax of 10% since all available profits will be remitted to Nigeria. The total tax payable on income in Outland is therefore 35% which is higher than the rate of Nigerian tax. This means that profits earned in Outland will not be taxed at all in Nigeria.

The management of the Nigerian parent company have to decide what the transfer price for the component should be and is considering two different transfer pricing scenarios.

Example (continued): Transfer pricing at market price

Transfer pricing scenario 1: Transfer price set at the market price (₦26 per unit).

The results of using this transfer price are as follows:

Parent company (Nigeria)	₦	₦
Component sales (₦26 per unit)	2,600,000	
Variable costs (₦15 per unit)	1,500,000	
Fixed costs	900,000	
	(2,400,000)	
Profit before tax	200,000	
Tax at 30%	(60,000)	
Profit after tax		140,000
Subsidiary company (Outland)	LC	
Product sales (LC150 per unit)	15,000,000	
Transfer costs (LC104 per unit)	10,400,000	
Local variable costs (LC40 per unit)	1,500,000	
Local fixed costs	600,000	
	(12,500,000)	
Profit before tax	2,500,000	
Tax at 25%	(625,000)	
Profit after tax	1,875,000	
Withholding tax at 10%	(187,500)	
Remitted to the Nigeria	1,687,500	
Exchange rate	÷4	
Received in Nigeria		421,875
Profit in Nigeria after tax		561,875

Example (continued): Transfer pricing at market price

Transfer pricing scenario 1: Transfer price set at cost plus 25%.

Total Nigerian costs are ₦2,400,000 or ₦24 per unit. Cost plus 25% = ₦30 per unit.

The transfer price will therefore be ₦30, which is LC120 per unit.

The results of using this transfer price are as follows:

Parent company (Nigeria)	₦	₦
Component sales (₦30 per unit)	3,000,000	
Variable costs (₦15 per unit)	1,500,000	
Fixed costs	900,000	
	(2,400,000)	
Profit before tax	600,000	
Tax at 30%	(180,000)	
Profit after tax		420,000
Subsidiary company (Outland)	LC	
Product sales (LC150 per unit)	15,000,000	
Transfer costs (LC120 per unit)	12,000,000	
Local variable costs (LC40 per unit)	1,500,000	
Local fixed costs	600,000	
	(14,100,000)	
Profit before tax	900,000	
Tax at 25%	(225,000)	
Profit after tax	675,000	
Withholding tax at 10%	(67,500)	
Remitted to the Nigeria	607,500	
Exchange rate	÷4	
Received in Nigeria		151,875
Profit in Nigeria after tax		571,875

Conclusion

The higher transfer price results in a bigger after-tax profit for the group. This is because it has the effect of reducing profits in Outland (where the group pays tax at 35% into Nigeria (where the group pays tax at 25%).

The tax authorities in Outland might not agree to accept a transfer price of LC 120 as this is LC 26 above the market price of LC 104.

5 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain suitable bases for transfer pricing
- Select suitable bases for transfer pricing
- Set optimal transfer prices

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

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 ₦410 (₦1,400 – ₦700 – ₦290).

The contribution from selling one unit of Product Y in the intermediate market is ₦300 (₦1,000 – ₦700).

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, ₦1,030. However, Division B can presumably find another supplier who is willing to offer the current market price of ₦1,000, and the maximum price that Division B should pay ought to be ₦1,000.

Step 3: What would motivate the selling division to make and transfer as many units of Product X as possible?

Product Y	**₦**
Variable cost	700
Opportunity cost of lost external sale (1,000 – 700)	300
Total cost = minimum transfer price	1,000

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	-	1,400	1,400
Internal sale	1,000	-	-
Sales revenue	1,000	1,400	1,400
Transfer: purchase cost	-	1,000	-
Other variable costs	700	290	990
Total variable costs	700	1,290	990
Contribution per unit	300	110	410

Skills level
Performance management

CHAPTER 12

Divisional performance

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

C	**Performance measurement and control**		
	3	**Divisional performance and transfer pricing**	
		e	Select and explain suitable divisional performance measures for a given business using return on investment, residual income and economic value added approaches. Evaluate the results and advise management.

Exam context

This chapter explains the different types of responsibility centres. It continues by explaining the advantages and disadvantages of decentralisation before explaining suitable techniques for measuring the performance of investment centres.

By the end of this chapter, you should be able to:

- Explain and illustrate cost centres, profit centres and investment centres
- Define, calculate and interpret return on investment
- Define, calculate and interpret residual income
- Define, calculate and interpret economic value added

1 INVESTMENT, PROFIT, REVENUE AND COST CENTRES

Section overview

- Organisational structure and management responsibilities
- Definitions and explanation

1.1 Organisational structure and management responsibilities

Every business organisation has a management structure with individual managers given responsibility for a particular aspect of operations or activity. The operations or activity for which they are responsible can be called a **responsibility centre**. Within a large organisation, there is a hierarchy of management, with a hierarchy of delegated responsibilities.

A manager might be in charge of a department, such as a warehouse or the buying department. A part of their responsibility should be to ensure that the department operates efficiently and economically, and that costs (expenditures) are kept under control. A departmental manager is likely to be responsible for preparing the annual cost budget for the departments, subject to approval by his superiors. A manager who is made responsible for costs must have some authority over spending in his department (although a large proportion of departmental costs, such as employees' salaries, might be outside his control).

A manager might be responsible for a department or activity that earns revenue, and for the revenue earned by the department. For example a sales manager might be made responsible for the activities of a sales team and the revenue that the sales team earns. Similarly, the manager of a retail store (in a company that operates a chain of stores) might be responsible for the revenues earned by the store. A manager who is made responsible for revenues might have some authority to adjust or decide selling prices; alternatively a manager might be told what the sales prices will be and is them made responsible for the volume of sales at those prices.

When a manager is responsible for both the costs and the revenues of an operation or department, he (or she) is also responsible for the profits that it earns.

In some cases, a manager might have the responsibility to make decisions about capital investment for an operation, with authority to buy new capital equipment or sell off unwanted assets. For example in a large company or a group of companies, there might be operating divisions where the divisional manager has a large amount of autonomy, with authority over capital spending ('capital budgets') as well as revenues, costs and profits.

1.2 Definitions and explanation

Managers need management accounting information to help them make decisions. Responsibility centres can be divided into four categories:

Investment centres.

An investment centre is a division within an organisation where the manager is responsible not only for the costs of the division and the revenues that it earns, but also for decisions relating to the investment in assets for the division. An investment centre manager usually has authority to purchase new assets, such as items of plant or equipment, and so should be responsible for the profit or 'return' that the division makes on the amount that it has invested.

The performance of an investment centre might be measured by calculating the profit as a percentage of the amount invested (the return on investment or ROI).

An investment centre might include a number of different profit centres. For example, a company manufacturing cars and trucks might have two investment centres, (1) car-making and (2) truck-making. Within the truck-making division, there might be several profit centres, each of these a separate location or factory at which trucks are manufactured and assembled.

Profit centres.

A profit centre is a department or division within the organisation for which revenues as well as costs are established.

The profit (or loss) that the centre makes is found by measuring the costs of the products or services produced by the centre, and the revenues earned from selling them,.

Example: Summarised profit centre report

Example: summarised profit centre report	₦000
Revenues of the profit centre	250
Costs of the units sold by the profit centre	(220)
Profit (or loss) of the profit centre	30

A profit centre might consist of several cost centres. For example, a factory might be treated as a profit centre, and within the factory, the machining department, assembly department and finishing department might be three cost centres.

Revenue centres.

A revenue centre is a department or division within the organisation for which revenues are established. In a revenue centre there is no measurement of cost or profit. Revenue centre managers will only need to have information relating to revenues and will be accountable for revenues only. For example, the income accountant in a hospital is only responsible for recording and controlling the different incomes that are received from funding bodies or other sources (for example, private patients, fundraising and so on).

Cost centres.

A cost centre is a department or work group for which costs are established, in order to measure the cost of output produced by the centre. For example, in a factory a group of machines might be a cost centre. The costs of operating the machines would be established, and a cost could then be calculated for each unit of product manufactured by the machines.

In a cost centre, there is no measurement of revenue or profit.

Example: Responsibility centres

A media company has several divisions.

One is a magazine publishing division. This division is divided into three operating units: fashion magazines, sports magazines and business magazines, which operate from different offices.

The fashion magazines unit has three main functions: commissioning, editing and printing, and marketing and sales.

The media company might organise its cost and management system as follows:

Investment centres

Each of the divisions in the media company, including the magazines division, might be an investment centre. The senior manager of the magazines division might have the authority to incur capital expenditure to acquire new assets for the division. The performance of the magazines division might be measured by its annual return on investment (ROI).

Profit centres

Within the magazines division, the fashion magazines unit, sports magazines unit and business magazines unit might be profit centres. The manager of each unit might be responsible for the revenues and costs of the unit, and the performance of each unit would be measured by the profit that it makes.

Cost centres

Within the fashions magazine unit, each of the operating functions (commissioning, editing and printing, and marketing and sales) might be a cost centre. The manager in charge of each cost centre is responsible for costs, and the performance of the cost centre might be measured by comparing the actual costs of the cost centre with its budgeted costs.

The differing information needs of cost, revenue, profit and investment centre management

Managers of responsibility centres are responsible for the performance of their part of the organisation and its activities. The performance of an organisation is often measured financially, in terms of:

- keeping expenditure under control;
- earning a sufficient amount of revenue;
- making a profit;
- making a suitable return on investment.

Managers therefore need information about the costs of operations for which they are responsible. They will often also need information about revenues and profit. In some cases, they will also need information about the amount of property, plant and equipment, and other ‘assets’ for which they are responsible. The information they need to make decisions within their area of responsibility depends on the scope of their management authority and responsibilities.

Managers also need financial information to help them make decisions. For example, they might need information about expected costs to make a decision about how much to charge a customer for a job. Similarly, they might need information about costs and revenues to decide whether to invest money in a new project.

Management accounting is concerned with providing information to management to help them with planning and control, and for making other decisions.

The accounting information provided to managers should help them to make decisions, and the information provided should be relevant for the decisions they have to make. Clearly, the nature and content of the accounting information required depends on the nature of the manager’s responsibilities (i.e. on the type of responsibility centre).

2 DIVISIONAL PERFORMANCE EVALUATION

Section overview

- Decentralisation of authority
- Benefits of decentralisation
- Disadvantages of decentralisation
- Controllable profit and traceable profit

2.1 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.

2.2 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.

2.3 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.

2.4 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.

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 were covered in the previous chapter.

Example: Controllable profit

	₦
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) (1)	280,000
Costs traceable to the division but outside the manager's control	(160,000)
Profit traceable to the division (2)	120,000
Share of general overheads (3)	(30,000)
Net profit	90,000

Notes:

1 Controllable profit is used to assess the manager.

2 Traceable profit is used to assess the performance of the division.

3 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.

3 RETURN ON INVESTMENT (ROI)

Section overview

- The reason for using ROI as a financial performance indicator
- Measuring ROI
- ROI and investment decisions
- Advantages and disadvantages of ROI for measuring performance

3.1 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: Return on investment

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% (₦250,000/₦5 million). Centre 2 employed assets of just ₦1 million to earn its profit and its ROI was 15% (₦150,000/₦1 million). Comparing performance on the basis of ROI, Centre 2 performed better.

3.2 Measuring ROI

ROI is the profit of the division as a percentage of capital employed.

However, performance measurement systems should use ROI to evaluate the performance of both the manager and the division.

Although ROI can be measured in different ways, the recommended measures are as follows:

Formula: Return on investment – managerial evaluation

$$\text{ROI} = \frac{\text{Controllable profit}}{\text{Division's capital employed (size of investment)}} \times 100\%$$

Formula: Return on investment – divisional evaluation

$$\text{ROI} = \frac{\text{Traceable profit}}{\text{Division's capital employed (size of investment)}} \times 100\%$$

Profit is usually measured as an accounting profit, 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.
- 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.

Where possible, the capital employed by the division should be analysed into:

- capital (assets less liabilities) controllable by the manager, and
- capital (assets and liabilities) traceable to the division.

Example: Return on investment

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.

3.3 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: ROI and investment decisions

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 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.

Should the investment centre manager decide to undertake this investment or not?

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.

3.4 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.

4 RESIDUAL INCOME (RI)

Section overview

- Measuring residual income
- Imputed interest (notional interest) and the cost of capital
- Residual income and investment decisions
- Advantages and disadvantages of residual income

4.1 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 is measured in either of the following ways:

Illustration: Residual income – Managerial evaluation

	₦
Controllable profit	X
Less notional interest on average controllable investment	(X)
Controllable residual income	X

Illustration: Residual income – Divisional evaluation

	₦
Traceable profit	X
Less notional interest on average traceable investment	(X)
Divisional residual income	X

4.2 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: Residual income

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?

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.

4.3 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.

Example: Residual income and investment decisions

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 division 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.

Should the investment centre manager decide to undertake this investment or not?

Answer

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 working)	(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.

Workings:	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Notional interest	**₦**	**₦**	**₦**	**₦**
Average investment	870,000	850,000	830,000	810,000
Notional interest at 12%	104,400	102,000	99,600	97,200

4.4 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 is 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.

Practice question **1**

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.

5 DIVISIONAL PERFORMANCE AND DEPRECIATION

Section overview

- ROI or RI: the problem with depreciation

5.1 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.

These effects can be seen in the following practice question:

Practice question **2**

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:

(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.

6 ECONOMIC VALUE ADDED (EVA)

Section overview

- Profits and adding value to a business
- The potential benefits of EVA
- Measuring economic value added (EVA)
- Using EVA
- Possible problems with EVA

6.1 Profits and adding value to a business

In theory, if a company makes a profit, the value of its shares ought to increase by the amount of the profit (less any dividends paid to shareholders). In practice, this does not happen.

One reason for this is that in order to make a profit, capital is invested. Capital is a resource which has a cost. The actual creation of extra value should therefore be the profit less the cost of capital invested. Residual income is the accounting profit earned by a division less a notional charge for capital employed. In theory, there is a connection between residual income and the expected increase in the value of a business.

Peter Drucker once wrote that: ‘until a business returns a profit that is greater than its cost of capital, it operates at a loss.’

Example: Profit and capital

A company has ₦10 million in cash and keeps it in a bank deposit account earning 2% per year interest.

The cash will earn interest of ₦200,000 less tax in one year, and this will be reported as income. However although keeping money in a low-interest account adds to accounting profit, it does not ’add value’ to the company (or ‘create value’), because the cost of capital needed to finance the cash is probably higher than 2%.

There is a second – and more important – reason why profits are not a good measure of the expected increase in the value of a business. This is that profit measured by accounting conventions is not a proper measure of ‘real’ economic profit.

It can be argued that using **economic profit** instead of accounting profit would lead to better measurement of the increase in the value of a business during a given period of time.

Stern Stewart (a management consultancy firm) devised a method of measuring economic profit, which they have called economic value added or EVA. The term ‘EVA’ is a trademark of the Stern Stewart organisation.

6.2 The potential benefits of EVA

EVA is a measure of performance that is a close approximation of 'economic profit'. Economic profit is measured in terms of the addition of economic value. An entity earns an economic profit only if it creates economic value through its activities. By creating economic value, a company should add to the wealth of its owners, the shareholders.

Using EVA to measure performance could therefore have the following benefits:

- It measures the creation of value by a company, and is a more 'accurate' measurement of performance than accounting profit.
- Economic value can be created when expectations of future profitability improve, because economic value can be measured as the net present value of future profits. EVA therefore recognises the benefit of activities, such as new investments, that add to longer-term profitability. Unlike accounting measures of profitability, EVA is not focused exclusively on the short-term.
- Management is encouraged to focus on the creation of value (EVA), which is in the long-term interests of shareholders.
- Management reward schemes based on EVA are likely to align the interests of management and shareholders more closely than a bonus system linked to annual accounting profits.
- It is a simple measure, like profit, and so one that line managers (including those with limited financial understanding) can understand.

6.3 Measuring economic value added (EVA)

Economic value added (EVA) for a financial period is the economic profit after deducting a cost for the value of capital employed.

The formula for EVA is as follows:

Formula: Economic value added (EVA)

EVA = Net operating profit after tax – (Capital employed × Cost of capital)

or

EVA = NOPAT – (Capital employed × WACC)

Where:

WACC = Weighted average cost of capital

In practice the computation of EVA involves making adjustments to accounting profit and the accounting value (book value) of assets. These adjustments can be complex.

NOPAT

The net operating profit after tax is calculated by making adjustments to the accounting profit in order to arrive at an estimate of economic profit. NOPAT is similar to 'free cash flow' and is an estimate of economic profit before deducting a cost for the capital employed. The calculation of NOPAT requires a number of different adjustments to the figure for accounting profit.

(1) **Interest costs**. In calculating NOPAT, interest costs of debt capital should not be deducted from profit. This is because debt capital is included in the capital employed. NOPAT should be the profit before deducting interest costs but after deducting tax. There is tax relief on interest, so to reach a figure for NOPAT the amount of interest charges in the period less relief on the interest cost should be added back to the figure for profit after tax.

NOPAT = Profit after tax + [Interest costs less tax relief on the interest]

(2) **Depreciation**. Non-cash expenses should not be deducted from profit. The main item of non-cash expense is usually depreciation of non-current assets. However, there should be a charge for non-current assets, to allow for the economic consumption of value that occurs when the assets are used.

NOPAT = Profit after tax + Post-tax interest cost + [Accounting depreciation – Economic depreciation]

If it can be assumed that accounting depreciation charges are similar to the loss of economic value in non-current assets, the two items cancel out, and:

NOPAT = Profit after tax + [Interest costs less tax relief on the interest]

(3) **Other non-cash expenses**. Other non-cash expenses should also be added back in order to measure NOPAT. These include additional provisions for irrecoverable debts and other provisions.

(4) **Investments in intangible items**. Investments in intangible items include spending on promotion activities, investing in a brand name, research and development spending and spending on employee training (to increase the economic value of the work force). In conventional accounting systems, these items of expense are usually written off as expenses in the year that they occur. However, they are items of discretionary spending by management that add to the value of the business.

To measure NOPAT, these items of expense that have been written off in the conventional accounts should be added back.

(They should also be added to the value of the company's capital. Economic depreciation charges will be applied as appropriate to this economic capital, in subsequent years.)

Charge for capital

EVA is NOPAT minus a charge to represent the cost of capital employed. There are two elements to the capital charge:

- the value of the company's assets; and
- the cost of capital.

Capital employed.

The valuation of capital employed should be based on economic values of the capital employed. In most cases, this means that non-current assets should be valued close to their current value, rather than at a value based on historical cost.

In a simplified system for measuring the economic value of a company's capital employed, the starting point is the book value of the company's net assets. This is:

- book value of non-current assets at the beginning of the year; plus
- book value of net current assets at the beginning of the year.

Some adjustments should then be made for:

- **Investments in intangibles**- Spending on intangible items should be added back in calculating NOPAT, as explained earlier. In addition, the net book value of intangible items should be included in capital employed, and so an estimate of the net book value of the intangibles should be added to the accounting value of the company's net assets.
- **Provisions and allowances**- Additions during the year to allowances for irrecoverable debts and additions to provisions should be added back to profit in calculating NOPAT. The total amount of allowances for irrecoverable debts, provisions for deferred tax and other provisions should also be added to capital employed.
- **Off-balance sheet financing and operational leases**- Some companies keep items of capital off their balance sheet (statement of financial position). A notable example is assets held on operating leases. The acquisition of leased assets is a form of debt finance, because the lessor (provider of the leased asset) has provided the financing for the assets that the company is leasing. The estimated value of assets held under operating lease agreements (and the value of any other assets financed 'off balance sheet') should be added to capital employed.

Cost of capital

The capital charge is calculated by applying the weighted average cost of capital (WACC) to the value of capital employed.

WACC is the weighted average of equity capital and debt capital **in the company's target debt structure**.

- If the current debt structure of the company is close to the long-term target debt structure of the company, the weighted average cost of capital can be calculated from the current value of equity and debt capital.
- However if the target capital structure is different from the current capital structure, the weighted average cost of capital is calculated using the target proportions of equity and debt.
- The cost of equity and the cost of debt can vary from one year to the next. A new WACC may therefore be calculated each year, with appropriate costs for equity and debt in each year.

Example: WACC

A company currently has equity capital valued at ₦800 million and debt capital of ₦400 million. Its target is to achieve 50% equity and 50% debt in its capital structure.

In the current year the cost of equity was 15% and the cost of debt was 10%. The rate of tax is 30%.

The WACC for the purpose of calculating EVA is therefore:

(15% × 50%) + [10% (1 – 0.30) × 50%] = 11%.

The following example shows the calculation of EVA, at a level of complexity that you may meet in the examination.

Example: Economic Value Added (EVA)

Owerri Distribution Limited's income statement and statement of financial position for the year just ended are (year 1) as follows:

Income statement	**Year 1**
	₦000
Profit before interest and tax	62,000
Interest cost	6,000
Profit before tax	56,000
Tax at 25%	14,000
Profit after tax	42,000
Dividends paid	24,000
Retained profit	18,000

Statement of financial position	**Year 1**
	₦000
Non-current assets	265,000
Net current assets	170,000
	435,000
Shareholders' funds	345,000
Long-term and medium-term debt	90,000
	435,000

Notes

1 Capital employed at the beginning of the year was ₦410 million.

2 The company had non-capitalised leased assets of ₦18 million in the year. These assets are not subject to depreciation.

3 The estimated cost of equity in the year 1 was 10% and the cost of debt was 7%.

4 The company's target capital structure is 50% equity and 50% debt.

5 Accounting depreciation was equal to economic depreciation so there is no need to make an adjustment to get from accounting depreciation to economic depreciation.

6 Other non-cash expenses were ₦14 million.

Example (continued): EVA

EVA is calculated as follows:

Net operating profit after tax	**Year 1**
	₦000
Profit after tax	42,000
Add: Interest cost less tax: (6,000 less 25%)	4,500
Add: Non-cash expenses	14,000
NOPAT	60,500

Capital employed	**Year 1**
	₦000
Book value of total assets less current liabilities	410,000
Non-capitalised leased assets	18,000
	428,000

WACC = (10% × 50%) + [7% (1 – 0.25) × 50%] = 7.625%.

EVA	**Year 1**
	₦000
NOPAT	60,500
Capital charge: (428,000 × 7.625%)	32,635
Economic value added (estimate)	27,865

Practice question **3**

Owerri Distribution Limited's income statement and statement of financial position for the year just ended (year 2).

Income statement	**Year 2**
	₦000
Profit before interest and tax	80,000
Interest cost	8,000
Profit before tax	72,000
Tax at 25%	18,000
Profit after tax	54,000
Dividends paid	29,000
Retained profit	25,000

Statement of financial position	**Year 2**
	₦000
Non-current assets	280,000
Net current assets	200,000
	480,000
Shareholders' funds	370,000
Long-term and medium-term debt	110,000
	480,000

Notes

1 Capital employed at the beginning of Year 2 was ₦435 million.

2 The company had non-capitalised leased assets of ₦18 million in the year. These assets are not subject to depreciation.

3 The estimated cost of equity in Year 2 was 12% and the cost of debt was 8%.

4 The company's target capital structure is 50% equity and 50% debt.

5 Accounting depreciation was equal to economic depreciation during the year.

6 Other non-cash expenses were ₦16 million.

Required

Calculate EVA for the year and comment on the results for year 1 (see the previous example) and year 2.

In summary, computation of EVA can be achieved thus:

A. Calculating net operating profit after tax (NOPAT):

In calculating net operating profit (NOPAT), the following adjustments are very important on profit after tax:
Add capitalised research and development for the year.
Add net interest (1-t) (where t =tax rate)
Add capitalised promotion for the year.
Add training cost capitalised for the year.
Add marketing cost capitalised for the year.
Add financial depreciation for the year.
Less economic depreciation for the year.
Add provisions and allowances for bad debt, inventories for the year.
Add deferred tax provision.
Less cash tax
Add non- cash expenses
= net operating profits after tax (NOPAT)

B. Computation of finance charge (WACC) on capital structure:

WACC = [ke × E/E+D] + [kd (1 – t) × D/ E + D]
Where ke = required return on equity (E)
Kd(1 – t) = after tax return on debt (D).

C. Computation of opening capital employed:

Capital employed (opening capital employed)
Add capitalised cost relating to opening capital invested.
Add provision/allowances relating to opening capital invested.
Add non cash expenses to capital employed
Add capitalised cost of operating leases to capital employed.

D. Computation of EVA

Net operating profits after tax (NOPAT)
Less WACC of computed opening capital employed
Economic value added

6.4 Using EVA

If it is measured with reasonable accuracy, EVA should be a measure, in economic terms, of how much extra value or wealth has been created by a business operation during a period.

It can therefore be argued that EVA would be a much more useful measure of divisional performance – and company performance – than traditional accounting measures of ROCE and profit.

The problem with EVA however is its complexity. To arrive at an estimate of EVA, it is necessary to make many adjustments to accounting values for profit and asset values, and there might be some uncertainty about the reliability of the figure that is calculated as EVA. It might also be questioned whether the extra cost of calculating EVA (compared with ROCE or ROI/residual income) is justified.

EVA and measuring the performance of divisions

EVA can be used as an alternative to ROI or residual income as a method of measuring the performance of operating divisions. However, using EVA for performance measurement of operating divisions might make little sense unless the company as a whole also measured its total performance in terms of EVA.

6.5 Possible problems with EVA

There are several potential problems with the use of EVA.

- It is not easy to use EVA for inter-firm comparisons or inter-divisional performance comparisons, because it is an absolute measure (in ₦) rather than a comparative measure (such as a ratio).
- The adjustments required to get from accounting profit to NOPAT and from accounting capital employed to economic capital employed can be complex. In particular, it may be very difficult to estimate economic depreciation.

7 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain and illustrate cost centres, profit centres and investment centres
- Define, calculate and interpret return on investment
- Define, calculate and interpret residual income
- Define, calculate and interpret economic value added

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

	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.

Solution **2**

	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.

Solution **3**

Net operating profit after tax	**Year 1**
	₦000
Profit after tax	54,000
Add: Interest cost less tax: (8,000 less 25%)	6,000
Add: Non-cash expenses	16,000
NOPAT	76,000

Capital employed	**Year 1**
	₦000
Book value of total assets less current liabilities	435,000
Non-capitalised leased assets	18,000
	453,000

WACC = (12% × 50%) + [8% (1 – 0.25) × 50%] = 9%.

EVA	**Year 1**
	₦000
NOPAT	76,000
Capital charge: (453,000 × 9%)	40,770
Economic value added (estimate)	35,230

These figures suggest that in each year the company created value, because the EVA was positive.

Financial performance in Year 2 was better than in Year 1 because the EVA is higher.

Skills level
Performance management

CHAPTER 13

Relevant costs

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**			
	1	**Advanced decision-making and decision-support**		
		a	Select and calculate suitable relevant cost based on given data and information. Evaluate the results and advise management.	
				NB. Computation and interpretation of shadow prices are also required.

Exam context

This chapter explains which costs and revenues are relevant to decision making. The knowledge acquired in this chapter provides a foundation to later chapters on specific areas of decision making. Study it carefully.

By the end of this chapter, you should be able to:

- Understand and explain the concept of relevant costing
- Explain the terms, incremental cost, differential cost, committed cost, sunk cost and opportunity cost
- Identify relevant costs (revenues) in a variety of situations

1 THE CONCEPT OF RELEVANT COSTING

Section overview

- Information for decision-making
- Marginal costing and decision-making
- Relevant costs and decision-making
- Terms used in relevant costing
- Opportunity costs

1.1 Information for decision-making

Management makes decisions about the future. When they make decisions for economic or financial reasons, the objective is usually to increase profitability or the value of the business, or to reduce costs and improve productivity.

When managers make a decision, they make a choice between different possible courses of action (options), and they need relevant and reliable information about the probable financial consequences of the different options available. A function of management accounting is to provide information to help managers to make decisions, by providing estimates of the consequences of selecting any option.

Traditionally, cost and management accounting information was derived from historical costs (a measurement of actual costs). For example, historical costs are used to assess the profitability of products, and control reporting typically involves a comparison of actual historical costs with a budget or standard costs.

Accounting information for decision-making is different, because decisions affect the future, not what has already happened in the past. Accounting information for decision-making should therefore be based on estimates of future costs and revenues.

- Decisions affect the future, but cannot change what has already happened. Decision-making should therefore look at the future consequences of a decision, and should not be influenced by historical events and historical costs.
- Decisions should consider what can be changed in the future. They should not be influenced by what will happen in the future that is unavoidable, possibly due to commitments that have been made in the past.
- Economic or financial decisions should be based on future cash flows, not future accounting measurements of costs or profits. Accounting conventions, such as the accruals concept of accounting and the depreciation of non-current assets, do not reflect economic reality. Cash flows, on the other hand, do reflect the economic reality of decisions. Managers should therefore consider the effect that their decisions will have on future cash flows, not reported accounting profits.

1.2 Marginal costing and decision-making

Marginal costing might be used for decision-making. For example, marginal costing is used for limiting factor analysis and linear programming.

It is appropriate to use marginal costing for decision-making when it can be assumed that future fixed costs will be the same, no matter what decision is taken, and that all variable costs represent future cash flows that will be incurred as a consequence of any decision that is taken.

These assumptions about fixed and variable costs are not always valid. When they are not valid, relevant costs should be used to evaluate the economic/financial consequences of a decision.

1.3 Relevant costs and decision-making

Relevant costs should be used for assessing the economic or financial consequences of any decision by management. Only relevant costs and benefits should be taken into consideration when evaluating the financial consequences of a decision.

A relevant cost is a future cash flow that will occur as a direct consequence of making a particular decision.

The key concepts in this definition of relevant costs are as follows:

- Relevant costs are **costs that will occur in the future**- They cannot include any costs that have already occurred in the past.
- Relevant costs of a decision are **costs that will occur as a direct consequence of making the decision**. Costs that will occur anyway, no matter what decision is taken, cannot be relevant to the decision.
- Relevant costs are **cash flows**- Notional costs, such as depreciation charges, notional interest costs and absorbed fixed costs, cannot be relevant to a decision.

1.4 Terms used in relevant costing

Several terms are used in relevant costing, to indicate how certain costs might be relevant or not relevant to a decision.

Incremental cost

An incremental cost is an additional cost that will occur if a particular decision is taken. Provided that this additional cost is a cash flow, an incremental cost is a relevant cost.

Example: Incremental cost

A company has identified that each cost unit it produces has the following costs:

	₦ in ‘000
Direct materials	50
Direct labour	20
	70
Fixed production overhead	30
Total absorption cost	100

The incremental cost of making one extra unit is ₦70,000. Making one extra unit would not affect the fixed cost base.

The above example assumes that the fixed cost per unit is the result of overhead absorption and that making one extra unit does not affect the fixed cost of the company.

If making extra units would result in the business incurring new fixed costs, these would be incremental and must be included as a relevant cost in any decision making process.

Example: Incremental fixed cost (stepped fixed costs)

A company owns a factory which has the capacity to produce 100,000 units per annum.

The factory is operating at 80% of this capacity (i.e. 80,000 units per annum are being made but the company could make an additional 20,000 units if required).

The variable cost per unit is ₦60.

The company has received an enquiry to supply 30,000 units per annum for the next 5 years at a sales price of ₦100.

In order to fulfil this order the company would have to rent additional premises to make the 10,000 units which it is unable to make in its current premises.

The rent of the additional premises is a fixed cost but it is incremental to the project and must be included in the decision making process.

What would the decision be if the rent were:

a) ₦300,000

b) ₦300,000?

	a	**b**
Incremental annual amounts	₦ in '000	₦ in '000
Revenue (10,000 units × **₦100)**	1,000	1,000
Variable costs (10,000 units × **₦60)**	(600)	(600)
	400	400
Fixed costs	(300)	(500)
	100	(100)
Decision	Accept the offer	Reject the offer

Making and selling 10,000 extra units would generate extra contribution of ₦400,000. However, the company must also consider the incremental fixed costs in order to make the correct decision.

Differential cost

A differential cost is the amount by which future costs will be different, depending on which course of action is taken. A differential cost is therefore an amount by which future costs will be higher or lower, if a particular course of action is chosen. Provided that this additional cost is a cash flow, a differential cost is a relevant cost.

Example: Differential cost

A company needs to hire a photocopier for the next six months. It has to decide whether to continue using a particular type of photocopier, which it currently rents for ₦2,000 each month, or whether to switch to using a larger photocopier that will cost ₦3,600 each month. If it hires the larger photocopier, it will be able to terminate the rental agreement for the current copier immediately.

The decision is whether to continue with using the current photocopier, or to switch to the larger copier.

One way of analysing the comparative costs is to say that the larger copier will be more expensive to rent, by ₦1,600 each month for six months.

The differential cost of hiring the larger copier for six months would therefore be ₦9,600.

Avoidable and unavoidable costs

An avoidable cost is a cost that could be saved (avoided), depending whether or not a particular decision is taken. An unavoidable cost is a cost that will be incurred anyway.

- Avoidable costs are relevant costs.
- Unavoidable costs are not relevant to a decision.

Example: Avoidable and unavoidable costs

A company has one year remaining on a short-term lease agreement on a warehouse. The rental cost is ₦100,000 per year. The warehouse facilities are no longer required, because operations have been moved to another warehouse that has spare capacity.

If a decision is taken to close down the warehouse, the company would be committed to paying the rental cost up to the end of the term of the lease. However, it would save local taxes of ₦16,000 for the year, and it would no longer need to hire the services of a security company to look after the empty building, which currently costs ₦40,000 each year.

The decision about whether to close down the unwanted warehouse should be based on relevant costs only.

Local taxes and the costs of the security services (₦56,000 in total for the next year) could be avoided and so these are relevant costs.

The rental cost of the warehouse cannot be avoided, and so should be ignored in the economic assessment of the decision whether to close the warehouse or keep it open for another year.

Committed cost

Committed costs are a category of unavoidable costs. A committed cost is a cost that a company has already committed to or an obligation already made, that it cannot avoid by any means.

Committed costs are not relevant costs for decision making.

Example: Committed cost

A company bought a machine one year ago and entered into a maintenance contract for ₦20,000 for three years.

The machine is being used to make an item for sale. Sales of this item are disappointing and are only generating ₦15,000 per annum and will remain at this level for two years.

The company believes that it could sell the machine for ₦25,000.

The relevant costs in this decision are the selling price of the machine and the revenue from sales of the item.

If the company sold the machine it would receive ₦25,000 but lose ₦30,000 revenue over the next two years – an overall loss of ₦5,000

The maintenance contract is irrelevant as the company has to pay ₦20,000 per annum whether it keeps the machine or sells it.

Leases normally represent a committed cost for the full term of the lease, since it is extremely difficult to terminate a lease agreement.

Sunk costs

Sunk costs are costs that have already been incurred (historical costs) or costs that have already been committed by an earlier decision. Sunk costs must be ignored for the purpose of evaluating a decision, and cannot be relevant costs.

Example: Sunk cost

A company must decide whether to launch a new product on to the market.

It has spent ₦900,000 on developing the new product, and a further ₦80,000 on market research.

A financial evaluation for a decision whether or not to launch the new product should ignore the development costs and the market research costs, because the ₦980,000 has already been spent. The costs are sunk costs.

1.5 Opportunity costs

An opportunity cost is a benefit that will be lost by taking one course of action instead of the next most profitable course of action.

Example: Opportunity costs

A company has been asked by a customer to carry out a special job. The work would require 20 hours of skilled labour time. There is a limited availability of skilled labour, and if the special job is carried out for the customer, skilled employees would have to be moved from doing other work that earns a contribution of ₦600 per labour hour.

A relevant cost of doing the job for the customer is the contribution that would be lost by switching employees from other work. This contribution forgone (20 hours × ₦600 = ₦12,000) would be an opportunity cost.

This cost should be taken into consideration as a cost that would be incurred as a direct consequence of a decision to do the special job for the customer. In other words, the opportunity cost is a relevant cost in deciding how to respond to the customer's request.

What would the decision be if the special job would generate a contribution of:

a) ₦15,000

b) ₦10,000?

	a	**b**
	₦	**₦**
Contribution earned	15,000	10,000
Contribution lost	(12,000)	(12,000)
	3,000	(2,000)
Decision	Accept the offer	Reject the offer

An opportunity cost is not an actual cost in the sense of an amount paid out as an expense. It is a comparative cost. In other words, it is a change in the overall cost that results from making one choice over another.

Similar comments can be made in respect of opportunity revenues (gains).

2 IDENTIFYING RELEVANT COSTS

Section overview

- Relevant cost of materials
- Relevant cost of labour
- Relevant cost of overhead

There are certain rules or guidelines that might help you to identify the relevant costs for evaluating any management decision.

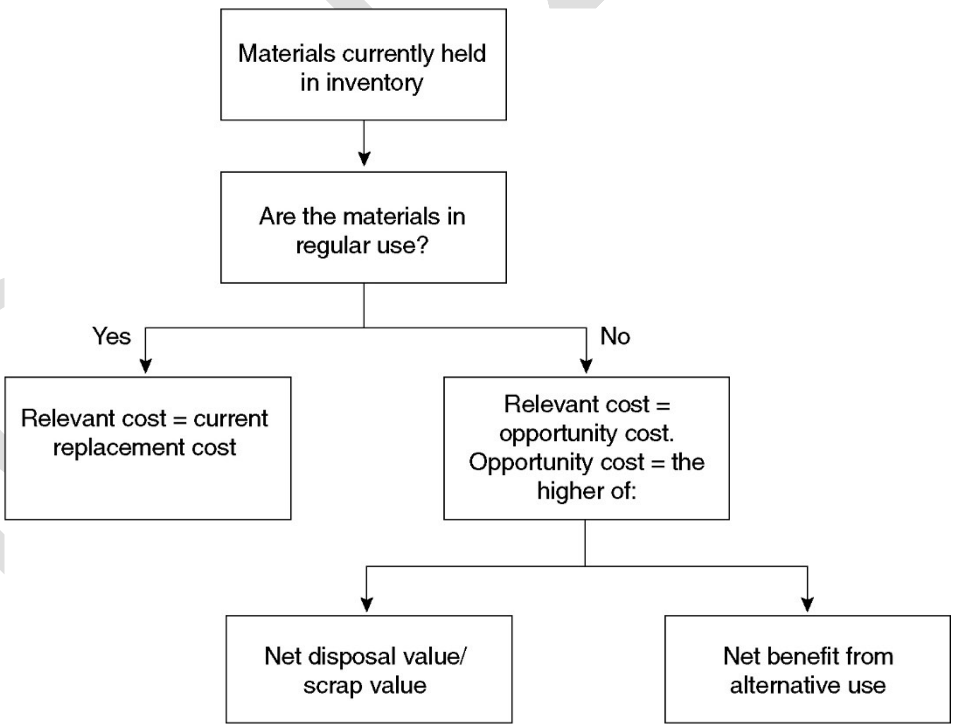
2.1 Relevant cost of materials

The relevant costs of a decision to do some work or make a product will usually include costs of materials. Relevant costs of materials are the additional cash flows that will be incurred (or benefits that will be lost) by using the materials for the purpose that is under consideration.

If **none of the required materials are currently held as inventory**, the relevant cost of the materials is simply their purchase cost. In other words, the relevant cost is the cash that will have to be paid to acquire and use the materials.

If **the required materials are currently held as inventory**, the relevant costs are identified by applying the following rules:

Illustration: Relevant cost of materials



Note that the historical cost of materials held in inventory cannot be the relevant cost of the materials, because their historical cost is a sunk cost.

The relevant costs of materials can be described as their 'deprival value'. The deprival value of materials is the benefit or value that would be lost if the company were deprived of the materials currently held in inventory.

- If the materials are regularly used, their deprival value is the cost of having to buy more units of the materials to replace them (their replacement cost).
- If the materials are not in regular use, their deprival value is either the net benefit that would be lost because they cannot be disposed of (their net disposal or scrap value) or the benefits obtainable from any alternative use. In an examination question, materials in inventory might not be in regular use, but could be used as a substitute material in some other work. Their deprival value might therefore be the purchase cost of another material that could be avoided by using the materials held in inventory as a substitute.

Example: Relevant cost of materials

A company has been asked to quote a price for a one-off contract.

The contract would require 5,000 kilograms of material X. Material X is used regularly by the company. The company has 4,000 kilograms of material X currently in inventory, which cost ₦400 per kilogram. The price for material X has since risen to ₦420 per kilogram.

The contract would also require 2,000 kilograms of material Y. There are 1,500 kilograms of material Y in inventory, but because of a decision taken several weeks ago, material Y is no longer in regular use by the company. The 1,500 kilograms originally cost ₦144,000, and have a scrap value of ₦36,000. New purchases of material Y would cost ₦100 per kilogram.

The relevant costs of the materials, to assist management in identifying the minimum price to charge for the contract are as follows.

Material X

This is in regular use. Any units of the material that are held in inventory will have to be replaced for other work if they are used for the contract. The relevant cost is their replacement cost.

Relevant cost = replacement cost = 5,000 kilograms × ₦420 = ₦2,100,000.

Material Y

This is not in regular use. There are 1,500 kilograms in inventory, and an additional 500 kilograms would have to be purchased. The relevant cost of material Y for the contract would be:

	₦
Material held in inventory (scrap value)	36,000
New purchases (500 × ₦100)	50,000
Total relevant cost of Material Y	86,000

2.2 Relevant cost of labour

The relevant costs of a decision to do some work or make a product will usually include costs of labour.

The relevant cost of labour for any decision is the additional cash expenditure (or saving) that will arise as a direct consequence of the decision.

- **If the cost of labour is a variable cost**, and labour is not in restricted supply, the relevant cost of the labour is its variable cost. For example, suppose that part-time employees are paid ₦180 per hour, they are paid only for the hours that they work and part-time labour is not in short supply. If management is considering a decision that would require an additional 100 hours of part-time labour, the relevant cost of the labour would be ₦180 per hour or ₦18,000 in total.
- **If labour is a fixed cost and there is spare labour time available**, the relevant cost of using labour is zero. The spare time would otherwise be paid for idle time, and there is no additional cash cost of using the labour to do extra work. For example, suppose that a new contract would require 30 direct labour hours, direct labour is paid ₦200 per hour, and the direct workforce is paid a fixed weekly wage for a 40-hour week. If there is currently spare capacity, so that the labour cost would be idle time if it is not used for the new contract, the relevant cost of using 30 hours on the new contract would be zero. The 30 labour hours must be paid for whether or not the contract work is undertaken.
- **If labour is in limited supply**, the relevant cost of labour should include the opportunity cost of using the labour time for the purpose under consideration instead of using it in its next-most profitable way. The cost of an hour of labour would be the pay per hour plus the lost contribution.

Example: Relevant cost of labour

Department 1. The contract would require 200 hours of work in department 1, where the workforce is paid ₦160 per hour for a fixed 40-hour week. There is currently spare labour capacity in department 1 and there are no plans to reduce the size of the workforce in this department.

Department 2. The contract would require 100 hours of work in department 2 where the workforce is paid ₦240 per hour. This department is currently working at full capacity. The company could ask the workforce to do overtime work, paid for at the normal rate per hour plus 50% overtime premium. Alternatively, the workforce could be diverted from other work that earns a contribution of ₦80 per hour.

Department 3. The contract would require 300 hours of work in department 3 where the workforce is paid ₦240 per hour. Labour in this department is in short supply and all the available time is currently spent making product Z, which earns the following contribution:

	₦	₦
Sales price		980
Labour (2 hours per unit)	480	
Other variable costs	300	
		780
Contribution per unit of product Z		200

Required

What is the relevant cost for the contract of labour in the three departments?

Answer

Department 1. There is spare capacity in department 1 and no additional cash expenditure would be incurred on labour if the contract is undertaken.

Relevant cost = zero

Department 2. There is restricted labour capacity. If the contract is undertaken, there would be a choice between:

- overtime work at a cost of ₦360 per hour (₦240 plus overtime premium of 50%) – this would be an additional cash expense, or
- diverting the labour from other work, and losing contribution of ₦80 per hour – cost per hour = ₦240 basic pay + contribution forgone ₦80 = ₦320 per hour.

It would be better to divert the workforce from other work, and the relevant cost of labour is therefore 100 hours × ₦320 per hour = ₦32,000.

Department 3. There is restricted labour capacity. If the contract is undertaken, labour would have to be diverted from making product Z which earns a contribution of ₦200 per unit or ₦100 per labour hour (₦200/2 hours). The relevant cost of the labour in department 3 is:

	₦
Labour cost per hour	240
Contribution forgone per hour	100
Relevant cost per hour	340

Relevant cost of 300 hours = 300 × ₦340 = ₦102,000.

Summary of relevant costs of labour:

	₦
Department 1	0
Department 2	32,000
Department 3	102,000
	134,000

2.3 Relevant cost of overheads

Relevant costs of expenditures that might be classed as overhead costs should be identified by applying the normal rules of relevant costing. Relevant costs are future cash flows that will arise as a direct consequence of making a particular decision.

Fixed overhead absorption rates are therefore irrelevant, because fixed overhead absorption is not overhead expenditure and does not represent cash spending

However, it might be assumed that the overhead absorption rate for **variable** overheads is a measure of actual cash spending on variable overheads. It is therefore often appropriate to treat a variable overhead hourly rate as a relevant cost, because it is an estimate of cash spending per hour for each additional hour worked.

The only overhead fixed costs that are relevant costs for a decision are extra cash spending that will be incurred, or cash spending that will be saved, as a direct consequence of making the decision.

Practice questions **1**

1 A company bought a machine six years ago for ₦125,000. Its written down value is now ₦25,000. The machine is no longer used for normal production work, and it could be sold now for ₦17,500. A project is being considered that would make use of this machine for six months. After this time the machine would be sold for ₦10,000.

Required

Calculate the relevant cost of the machine to the project.

2 A contract is under consideration which would require 1,400 hours of direct labour. There is spare capacity of 500 hours of direct labour, due to the cancellation of another order by a customer. The other time would have to be found by asking employees to work in the evenings and at weekends, which would be paid at 50% above the normal hourly rate of ₦15.

Alternatively, the additional hours could be found by switching labour from other work which earns a contribution of ₦5 per hour.

Required

Calculate the relevant cost of direct labour if the contract is accepted and undertaken.

3 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Understand and explain the concept of relevant costing
- Explain the terms, incremental cost, differential cost, committed cost, sunk cost and opportunity cost
- Identify relevant costs (revenues) in a variety of situations

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

1 Relevant cost = Difference between sale value now and sale value if it is used. This is the relevant cost of using the machine for the project.

Relevant cost = ₦17,500 - ₦10,000 = ₦7,500.

2 A total of 900 hours would have to be found by either working overtime at a cost of ₦15 × 150% = ₦22.50 per hour, or diverting labour from other work that earns a contribution of ₦5 per hour after labour costs of ₦15 per hour. The opportunity cost of diverting labour from other work is therefore ₦20 per hour. This is less than the cost of working overtime. If the contract is undertaken, labour will therefore be diverted from the other work.

It is assumed that the 500 hours of free labour time (idle time) available would be paid for anyway, even if the contract is not undertaken. The relevant cost of these hours is therefore ₦0.

Relevant cost of labour	**₦**
500 hours	0
900 hours (× ₦20)	18,000
Total relevant cost of labour	18,000

Skills level
Performance management

CHAPTER 14

Cost-volume-profit (CVP) analysis

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**		
	1	**Advanced decision-making and decision-support**	
		b	Select, calculate and present cost-volume-profit analyses based on a given data and information (including single and multiple products) using both numerical and graphical techniques. Advise management based on the results.

Exam context

This chapter explains how to estimate the break-even point in terms of the number of units sold and in terms of the revenue earned. It also explains how to calculate the margin of safety, and how to calculate the number of units that must be sold or revenue earned to achieve a target profit.

By the end of this chapter, you should be able to:

- Calculate the number of units that must be sold to achieve break-even
- Calculate the revenue that must be earned to achieve break-even
- Calculate the margin of safety associated with a given level of production in terms of the number of units sold or revenue
- Calculate the number of units that must be sold to achieve a target profit
- Calculate the revenue that must be earned to achieve a target profit

1 THE NATURE OF CVP ANALYSIS

Section overview

- Introduction to CVP analysis
- Assumptions in CVP analysis
- Contribution

1.1 Introduction to CVP analysis

CVP analysis stands for ***cost-volume-profit analysis***'. It is used to show how costs and profits change with changes in the volume of activity. CVP analysis is an application of marginal costing concepts.

This chapter explains CVP analysis and some of its applications.

1.2 Assumptions in CVP analysis

Costs are either fixed or variable. The variable cost per unit is the same at all levels of activity (output and sales). Total fixed costs are a constant amount in each period.

Fixed costs are normally assumed to remain unchanged at all levels of output.

The contribution per unit is constant for each unit sold (of the same product).

The sales price per unit is constant for every unit of product sold; therefore the contribution to sales ratio is also a constant value at all levels of sales.

If sales price per unit, variable cost per unit and fixed costs are not affected by volume of activity, sales and profits are maximised by maximising total contribution.

1.3 Contribution

Contribution is a key concept. Contribution is measured as sales revenue less variable costs.

Profit is measured as contribution minus fixed costs.

Illustration:

	₦
Sales (Units sold × sales price per unit)	X
Variable costs (Units sold × variable cost price per unit)	(X)
Contribution	X
Fixed costs	(X)
Profit	X

Total contribution = Contribution per unit × Number of units sold.

Many problems solved using CVP analysis use either contribution per unit (CPU) or the C/S (Contribution/Sales) ratio.

Contribution per unit

It is assumed that contribution per unit (sales price minus variable cost) is a constant amount over all sales volumes.

Example:

A company makes and sells a single product. The product has a variable production cost of ₦8 per unit and a variable selling cost of ₦1per unit.

Total fixed costs (production, administration and sales and distribution fixed costs) are expected to be ₦500,000.

The selling price of the product is ₦16.

The profit at sales volumes of 70,000, 80,000 and 90,000 units can be calculated as follows

	70,000 units	**80,000 units**	**90,000 units**
	₦	**₦**	**₦**
Sales revenue (₦16/unit)	1,120,000	1,280,000	1,440,000
Variable cost (₦9/unit)	(630,000)	(720,000)	(810,000)
Contribution (₦7/unit)	490,000	560,000	630,000
Fixed costs	(500,000)	(500,000)	(500,000)
Profit/(loss)	(10,000)	60,000	130,000

Notes

A loss is incurred at 70,000 units of sales because total contribution is not large enough to cover fixed costs. Profit increases as sales volume increases, and the increase in profit is due to the increase in total contribution as sales volume increases.

Somewhere between 70,000 and 80,000 there is a number of units which if sold would result in neither a profit nor a loss. This is known as the break-even position.

The contribution line could have been completed without calculating the sales and variable costs by simply multiplying the quantity sold by the contribution pper unit (CPU).

Example:

Facts as before but calculating total contribution as the number of units × contribution per unit.

Contribution per unit

	₦
Sales price per unit	16
Variable production cost per unit	(8)
Variable selling cost per unit	(1)
Contribution per unit	7

	70,000 units	**80,000 units**	**90,000 units**
	₦	**₦**	**₦**
70,000 × ₦7 per unit	490,000		
80,000 × ₦7 per unit		560,000	
90,000 × ₦7 per unit			630,000
Fixed costs	(500,000)	(500,000)	(500,000)
Profit/(loss)	(10,000)	60,000	130,000

C/S (Contribution/Sales) ratio

The sales revenue in each case could be calculated by dividing the total contribution for a given level of activity by the C/S ratio.

Formula: C/S ratio (contribution to sales ratio)

$$\frac{\text{Contribution per unit}}{\text{Selling price per unit}}$$

Example: C/S ratio

Contribution to sales ratio:

Contribution per unit/Selling price per unit = $^{7}/_{16}$ = 0.4375

	70,000 units	**80,000 units**	**90,000 units**
	₦	**₦**	**₦**
Contribution (₦7/unit)	490,000	560,000	630,000
C/S ratio	÷0.4375	÷0.4375	÷0.4375
Sales revenue	1,120,000	1,280,000	1,440,000

Notes

This may seem a little pointless here as the sales figures were obtained more easily in the first place by multiplying the numbers of units sold by the selling price per unit.

However, we have taken this opportunity to demonstrate this relationship.

2 BREAK-EVEN ANALYSIS

Section overview

- Break-even analysis
- Calculating the break-even point
- Margin of safety
- Target profit

2.1 Break-even analysis

CVP analysis can be used to calculate a break-even point for sales.

Break-even point is the volume of sales required in a period (such as the financial year) to ‘break even’ and make neither a profit nor a loss. At the break-even point, profit is 0.

Management might want to know what the break-even point is in order to:

- identify the minimum volume of sales that must be achieved in order to avoid a loss, or
- assess the amount of risk in the budget, by comparing the budgeted volume of sales with the break-even volume.

2.2 Calculating the break-even point

The break-even point can be calculated using simple CVP analysis.

At the break-even point, the profit is ₦0. If the profit is ₦0, **total contribution is exactly equal to total fixed costs**.

We therefore need to establish the volume of sales at which fixed costs and total contribution are the same amount.

Two methods of calculating the break-even point

There are a number of methods of calculating the break-even point when the total fixed costs for the period are known:

Method 1: Break-even point expressed as a number of units.

The first method is to calculate the break-even point using the contribution per unit. This method can be used where a company makes and sells just one product.

Formula: Break-even point expressed as a number of units

$$\text{Break-even point in sales units} = \frac{\text{Total fixed costs}}{\text{Contribution per unit}}$$

Total fixed costs are the same as the total contribution required to break even, and the break-even point can therefore be calculated by dividing the total contribution required (total fixed costs) by the contribution per unit.

Remember to include any variable selling and distribution costs in the calculation of the variable cost per unit and contribution per unit.

Once the break-even point is calculated as a number of units it is easy to express it in terms of revenue by multiplying the number of units by the selling price per item.

Example: Break-even point as number of units

A company makes a single product that has a variable cost of sales of ₦12 and a selling price of ₦20 per unit. Budgeted fixed costs are ₦600,000.

What volume of sales is required to break even?

Method 1

$$\text{Break-even point in sales units} = \frac{\text{Total fixed costs}}{\text{Contribution per unit}}$$

Contribution per unit = ₦20 – ₦12 = ₦8

Therefore break-even point:

In units: ₦600,000/₦8 per unit = 75,000 units of sales.

In sales revenue: 75,000 units × ₦20 per unit = ₦1,500,000 of sales.

Method 2: Break-even point expressed in sales revenue

The second method calculates the break-even point in sales revenue.

Formula: Break-even point expressed in sales revenue

$$\text{Break-even point in revenue} = \frac{\text{Fixed costs}}{\text{Contribution to sales ratio}}$$

Once the break-even point is calculated as an amount of revenue it is easy to express it as a number of units by dividing the revenue by the selling price per item.

Example: Break-even point as revenue

A company makes a single product that has a variable cost of sales of ₦12 and a selling price of ₦20 per unit. Budgeted fixed costs are ₦600,000.

What volume of sales is required to break even?

Method 2

$$\text{Break-even point in revenue} = \frac{\text{Total fixed costs}}{\text{C/S ratio}}$$

C/S ratio = ₦8/₦20 = 40%

Therefore break-even point:

In sales revenue = ₦600,000/0.40 = ₦1,500,000 in sales revenue.

In units = ₦1,500,000 ÷ ₦20 (sales price per unit) = 75,000 units.

2.3 Margin of safety

The margin of safety is the difference between:

- the budgeted sales (in units or ₦) and
- the break-even amount of sales (in units or ₦).

It is usually expressed as a **percentage of the budgeted sales**. However, it may also be measured as:

- a quantity of units (= the difference between the budgeted sales volume in units and the break-even sales volume), or
- an amount of sales revenue (= the difference between the budgeted sales revenue and the total sales revenue required to break even).

It is called the margin of safety because it is the maximum amount by which actual sales can be lower than budgeted sales without incurring a loss for the period. A high margin of safety therefore indicates a low risk of making a loss.

Example:

A company budgets to sell 25,000 units of its product. This has a selling price of ₦16 and a variable cost of ₦4. Fixed costs for the period are expected to be ₦240,000.

The break-even point = ₦240,000/(₦16 – 4) = 20,000 units.

The budgeted sales are 25,000 units.

Margin of safety	= Budgeted sales – break-even sales
	= 25,000 – 20,000 = 5,000 units

The margin of safety is often expressed as a percentage of budgeted sales.

Formula: Margin of safety ratio

$$\text{Margin of safety ratio} = \frac{\text{Margin of safety (units)}}{\text{Budgeted sales (units)}}$$

$$\text{Margin of safety ratio} = \frac{\text{Margin of safety (revenue)}}{\text{Budgeted revenue}}$$

Example: Margin of safety ratio

Returning to the previous example where the margin of safety was 5,000 units and budgeted sales were 25,000 units.

Margin of safety ratio 5,000 units/25,000 units =20% of budgeted sales

This means that sales volume could be up to 20% below budget, and the company should still expect to make a profit.

2.4 Target profit

Management might want to know what the volume of sales must be in order to achieve a target profit. CVP analysis can be used to calculate the volume of sales required.

The volume of sales required must be sufficient to earn a total contribution that covers the fixed costs and makes the target amount of profit. In other words the contribution needed to earn the target profit is the target profit plus the fixed costs.

The sales volume that is necessary to achieve this is calculated by dividing the target profit plus fixed costs by the contribution per unit in the usual way.

Formula: Target volume expressed in units

$$\text{Target volume (units)} = \frac{\text{Total fixed costs + target profit}}{\text{Contribution per unit}}$$

Once the target volume is calculated as a number of units it is easy to express it in terms of revenue by multiplying the number of units by the selling price per item.

Similarly the sales revenue that would achieve the target profit is calculated by dividing the target profit plus fixed costs by the C/S ratio.

Formula: Target volume expressed in sales revenue

$$\text{Target volume in revenue} = \frac{\text{Total fixed costs + target profit}}{\text{Contribution to sales ratio}}$$

Once the target volume is calculated as an amount of revenue it is easy to express it as a number of units by dividing the revenue by the selling price per item.

Example:

A company makes and sells a product that has a variable cost of ₦5 per unit and sells for ₦9 per unit.

Budgeted fixed costs are ₦600,000 for the year, and the company wishes to make a profit of at least ₦100,000.

The sales volume required to achieve the target profit can be found as follows:

The total contribution must cover fixed costs and make the target profit.

	₦
Fixed costs	600,000
Target profit	100,000
Total contribution required	700,000

Contribution per unit = ₦9 – ₦5 = ₦4.

Sales volume required to make a profit of ₦100,000:

₦700,000/₦4 per unit = 175,000 units.

Therefore the sales revenue required to achieve target profit

175,000 units × ₦9 = ₦1,575,000

Alternatively:

C/S ratio = 4/9

Sales revenue required to make a profit of ₦100,000

= ₦700,000 ÷ (4/9) = ₦1,575,000.

Therefore the number of units required to achieve target profit

₦1,575,000 ÷ ₦9 = 175,000 units

Practice questions **1**

1 A company makes a single product that it sells at ₦80 per unit. The total fixed costs are ₦360,000 for the period and the contribution/sales ratio is 60%. Budgeted production and sales for the period is 8,000 units.

Required

Calculate the margin of safety for the period, as a percentage of the budgeted sales.

2 A company makes and sells a single product. The following data relates to the current year's budget.

Sales and production (units):	8,000
Variable cost per unit:	₦20
Fixed cost per unit:	₦25
Contribution/sales ratio:	60%

The selling price next year will be 6% higher than the price in the current year budget and the variable cost per unit will be 5% higher than in the current year budget. Budgeted fixed costs next year will be 10% higher than budgeted fixed costs in the current year.

Required

(a) For the current year, calculate:

- (i) the budgeted contribution per unit
- (ii) the budgeted total profit

(b) For next year, calculate the number of units that will have to be sold in order to achieve a total profit that is equal to the budgeted profit in the current year.

3 (a) Entity D makes a single product which it sells for ₦10 per unit. Fixed costs are ₦48,000 each month and the product has a contribution/sales ratio of 40%.

Required

If budgeted sales for the month are ₦140,000, what is the margin of safety in units?

(b) Entity E has monthly sales of ₦128,000, but at this level of sales, its monthly profit is only ₦2,000 and its margin of safety is 6.25%.

Required

Calculate:

- (i) the monthly fixed costs
- (ii) the level of monthly sales needed to increase the monthly profit to ₦5,000.

3 BREAK-EVEN CHARTS AND PROFIT-VOLUME CHARTS

Section overview

- Break-even charts
- Profit/volume chart (P/V chart)

3.1 Break-even chart

A break-even chart is a chart or graph showing, for all volumes of output and sales:

- total costs, analysed between variable costs and fixed costs
- sales
- profit (the difference between total sales and total costs)
- the break-even point (where total costs = total sales revenue, and profit = zero).

The concept of a break-even chart is similar to a cost behaviour chart, but with sales revenue shown as well.

If the chart also indicates the budgeted volume of sales, the margin of safety can be shown as the difference between the budgeted volume and the break-even volume of sales.

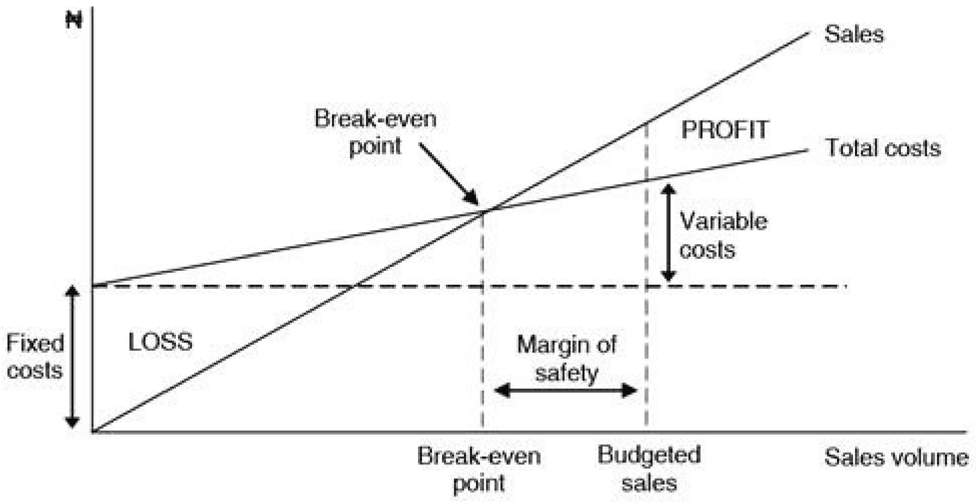
Two examples of break-even charts are shown below. The only difference between them is the way in which variable costs and fixed costs are shown.

- In the first diagram, variable costs are shown on top of fixed costs. Fixed costs are represented by the horizontal line of dashes. Fixed costs are the same amount at all volumes of sales. Variable costs are shown on top of fixed costs, rising in a straight line from sales of ₦0. Total costs are shown as the sum of fixed costs and variable costs.
- In the second diagram (a more unusual presentation), fixed costs are shown on top of variable costs. An advantage of this method of presentation is that total contribution is shown. This is the difference between the total sales line and the total variable costs line.
- Total costs are exactly the same in both diagrams.

Because the sales price per unit is constant, the total sales revenue line rises in a straight line from the origin of the graph (i.e. from x = 0, y = 0).

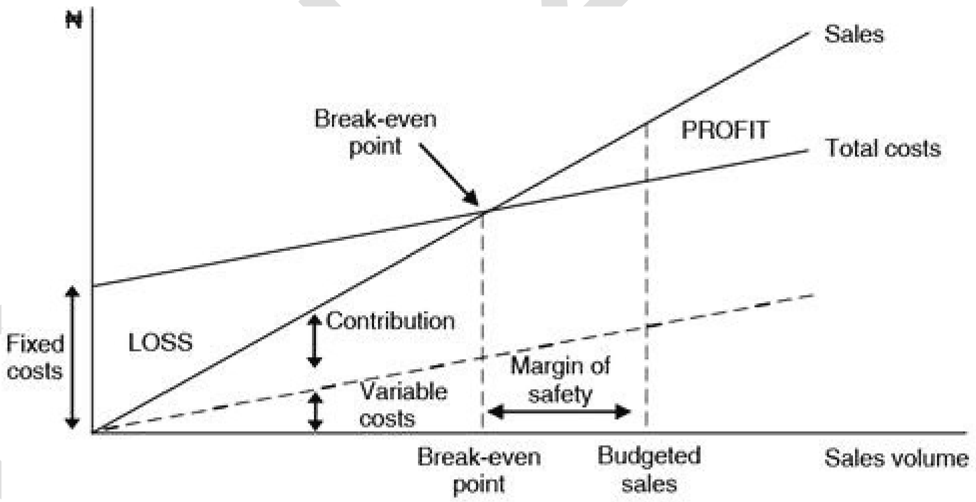
First break-even chart: variable costs on top of fixed costs

Illustration:



Second break-even chart: fixed costs on top of variable costs

Illustration:



Points to note

You should be able to identify the following points on these charts.

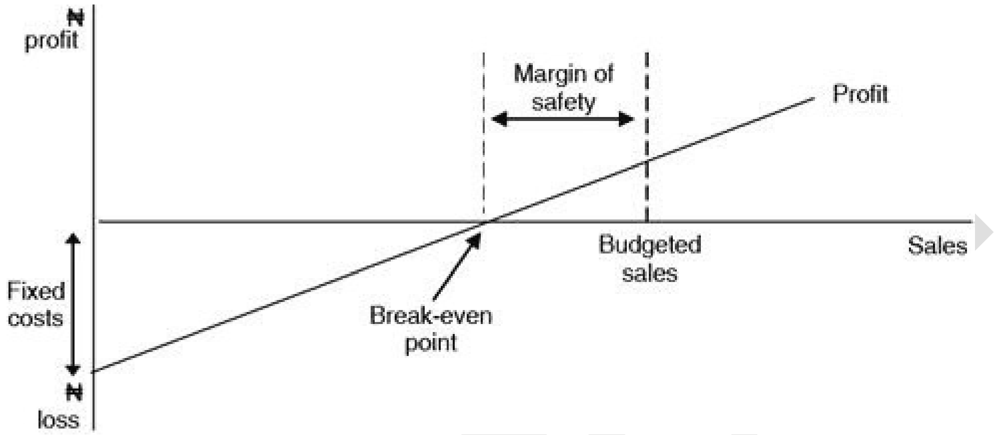
- The break-even point is shown on both charts as the volume of sales at which total revenue equals total costs.
- In the second chart, total contribution at the break-even point is shown as exactly equal to fixed costs.
- If budgeted sales are shown on the chart, the margin of safety can also be show, as the difference between budgeted sales and the break-even point.

3.2 Profit/volume chart (P/V chart)

A profit volume chart (or P/V chart) is an alternative to a break-even chart for presenting CVP information. It is a chart that shows the profit or loss at all levels of output and sales.

An example is shown below.

Illustration:



At ₦0 sales, there is a loss equal to the total amount of fixed costs. The loss becomes smaller as sales volume increases, due to the higher contribution as sales volume increases. Break-even point is then reached and profits are made at sales volumes above the break-even point.

We could draw a line on the graph to show fixed costs. This line should be drawn parallel to the x axis, starting at the loss (= total fixed costs) at ₦0 sales. By drawing this line for fixed costs, total contribution would be shown as the difference between the line showing the profit (or loss) and the line for the fixed costs.

Practice question **2**

You are a management accountant for a business that develops specialist computers. You are consulted to investigate the viability of marketing a new type of hand-held computer.

With the help of the manager of research and development, the production manager, the buyer and the sales manager, you have made the following estimates of annual sales and profitability:

Sales	Profit/(loss)
units	₦
12,000	(30,000)
15,000	150,000
18,000	330,000

The selling price will be ₦150.

Required

(a) Prepare a traditional break-even chart using the information given above.

(b) Calculate the margin of safety if annual sales are expected to be 15,000 units.

4 MULTI-PRODUCT CVP ANALYSIS

Section overview

- Introduction to multi-product break-even analysis
- Multi-product break-even analysis – weighted average unit approach
- Multi-product break-even analysis – Batch approach
- Margin of safety
- Target profit
- Multi-product break-even charts

4.1 Introduction to multi-product break-even analysis

So far we have assumed that the company is making and selling a single product. The techniques can be extended to multi-product situations. However, in order to do this we need to make a further assumption (which might seem very unrealistic).

This assumption is that products are sold in a set ratio which does not change with volume. This assumption allows us to tackle similar problems to those dealt with above in one of two ways. We could either use:

- weighted average contribution per unit and weighted average C/S ratio per unit; or
- contribution per batch and weighted average C/S ratio for the batch (assuming that goods are sold in the budgeted sales mix).

Note that there will be a single weighted average C/S ratio whether it is calculated using average units or from a batch.

Problems will be solved using each of these in turn.

4.2 Multi-product break-even analysis – weighted average unit approach

Weighted average contribution per unit

Example: Multi-product break-even using weighted average contribution per unit

The following budget information refers to the two products of a company.

	X	Y	
Sales price per unit	100	120	
Variable cost per unit	(75)	(111)	
Contribution per unit	25	9	
Sales volume	15,000	5,000	
Sales mix	3	1	
Fixed costs			315,000

The number of units at which the company will break even using the average contribution per unit is calculated as follows:

	₦	₦	₦
Contribution per unit	25	9	
Sales mix	15,000	5,000	
Contribution	375,000	45,000	420,000

Therefore, the weighted average contribution per unit is:

₦420,000/20,000 units = ₦21 per unit

Break-even as a number of units is given by:

Fixed costs/Contribution per unit = ₦315,000/₦21 = 15,000 units

These units are in the ratio of 3:1

The break-even in revenue can be found by multiplying the number of units above (15,000) by the weighted average revenue as follows:

	₦	₦	₦
Revenue per unit	100	120	
Sales mix	15,000	5,000	
Revenue	1,500,000	600,000	2,100,000

Therefore, the weighted average revenue per unit is:

₦2,100,000/20,000 units = ₦105 per unit

The break-even revenue is therefore 15,000 units × ₦105 = ₦1,575,000

The break-even sales volume of 15,000 units and the break-even revenue of ₦1,575,000 are totals for X and Y together. The next step is to work out the numbers for X and Y individually.

The 15,000 units are made up of units of X and Y in the ratio of 3 to 1. The ratio can be used to pro-rate the total to find the number of units of X and the number of units of Y sold at the break-even point.

The selling price for X and for Y can then be applied to these figures to arrive at the revenue from selling X and the revenue from selling Y.

Example (continued): Multi-product break-even using weighted average contribution per unit

Following on from the above:

The calculations of the sales volume of X and Y and the revenue from those sales are calculated as follows:

		Units		
	Units	**X (3 of 4)**	**Y (1 of 4)**	
Break-even	15,000	11,250	3,750	
Revenue per unit		₦100	₦120	
Revenue		₦1,125,000	₦450,000	= ₦1,575,000

Weighted average C/S ratio

Example: Multi-product break-even using weighted average C/S ratio

The weighted average C/S ratio can be calculated as follows:

Total contribution	₦	₦	₦
Contribution per unit	25	9	
Sales mix	15,000	5,000	
Contribution	375,000	45,000	420,000
Total revenue	₦	₦	₦
Revenue per unit	100	120	
Sales mix	15,000	5,000	
Revenue	1,500,000	600,000	2,100,000
Weighted average C/S ratio			
	₦420,000/₦2,100,000		0.20

Break-even in revenue is given by

Fixed costs/CS ratio = ₦315,000/0.20 = ₦1,575,000

The break-even revenue of ₦1,575,000 is the total for X and Y together. The next step is to work out the numbers for X and Y individually.

The total budgeted revenue of 2,100,000 (see the workings above) is made up of revenue from X of 1,500,000 and revenue from Y of 600,000. The same ratios are assumed to apply to all sales volumes. Therefore, the break-even revenue can be prorated on this basis to find the revenue from X and the revenue from Y at the break-even point. These figures can then be divided by the budgeted revenue for each to calculate the number of units of each sold at break-even.

The selling price for X and for Y can then be applied to these figures to arrive at the revenue from selling X and the revenue from selling Y.

Example (continued): Multi-product break-even using weighted average C/S ratio

Following on from the above:

The calculations of the revenue from sales of X and Y and the number of units sold to achieve these revenue figures are calculated as follows:

		Units		
	Revenue	**X ($^{1,500}/_{2,100}$)**	**Y ($^{600}/_{2,100}$)**	
Break-even	₦1,575,000	₦1,125,000	₦450,000	
Revenue per unit		÷ ₦100	÷ ₦120	
Units		11,250	3,750	15,000

4.3 Multi-product break-even analysis – Batch approach

Contribution per batch

This approach uses the contribution from a batch of items to calculate the number of batches that must be sold in order to break-even. Once this is known the budgeted sales mix can be applied to provide information at the unit level.

Formula: Break-even point for batches

$$\text{Break-even point in batches} = \frac{\text{Total fixed costs}}{\text{Contribution per batch}}$$

$$\text{Break-even point in revenue} = \frac{\text{Total fixed costs}}{\text{CS ratio for the batch}}$$

Example: Multi-product break-even using contribution per batch

The following budget information refers to the two products of a company.

	X	Y	
Sales price per unit	100	120	
Variable cost per unit	(75)	(111)	
Contribution per unit	25	9	
Sales volume	15,000	5,000	
Sales mix	3	1	
Fixed costs			315,000

The number of units at which the company will break even using the average contribution per batch is calculated as follows:

Batch	₦	₦	₦
Contribution per unit	25	9	
Sales mix	3	1	
Contribution (single batch)	75	9	84

Therefore, the contribution from selling a single batch is ₦84.

Break-even as a number of batches is given by:

Fixed costs/Contribution per batch = ₦315,000/₦84 = 3,750 batches

The break-even in revenue can be found by using the weighted average revenue per batch.

	₦	₦	₦
Revenue per unit	100	120	
Sales mix	3	1	
Revenue (single batch)	300	120	420

Therefore, the revenue from selling a single batch is ₦420.

The break-even revenue is therefore 3,750 batches × ₦420 = ₦1,575,000

The next step is to identify the number of units of X and Y in 3,750 batches and how much revenue is generated by each.

Example (continued): Multi-product break-even using contribution per batch

Following on from the above:

The calculations of the number of units of X and Y in 3,750 batches and the revenue from selling each are as follows:

		Units		
	Batches	**X (3 per batch)**	**Y (1 per batch)**	
Break-even	3,750	11,250	3,750	
Revenue per unit		₦100	₦120	
Revenue		1,125,000	450,000	= 1,575,000

Alternatively, the break-even in revenue for X and Y can be found by using the weighted average revenue per batch and these figures could be divided by the revenue per unit to arrive at the numbers of units.

	Total	**X ($^{300}/_{420}$)**	**Y ($^{120}/_{420}$)**
Break-even revenue	₦1,575,000	₦1,125,000	₦450,000
Revenue per unit		÷₦100	÷₦120
Number of units		11,250	3,750

C/S ratio using a batch

Example:

The following budget information refers to the two products of a company:

	X	Y	
Sales price per unit	100	120	
Variable cost per unit	(75)	(111)	
Contribution per unit	25	9	
Sales volume	15,000	5,000	
Sales mix	3	1	
Fixed costs			315,000

The break-even revenue using the average C/S ratio for the batch can be calculated as follows:

	₦	₦	₦
Sales price per unit	100	120	
Sales mix	3	1	
Revenue (single batch)	300	120	420
Contribution per unit	25	9	
Sales mix	3	1	
Contribution (single batch)	75	9	84

Weighted average CS ratio: ₦84/₦420 = 0.20 (Note that ₦300 out of every ₦420 will be revenue from selling X and ₦120 from selling Y).

Break-even in revenue is given by

Fixed costs/CS ratio = ₦315,000/0.20 = ₦1,575,000

		Units		
	Revenue	**X ($^{300}/_{420}$)**	**Y ($^{120}/_{420}$)**	
Break-even	₦1,575,000	₦1,125,000	₦450,000	
Revenue per unit		÷ ₦100	÷ ₦120	
Units		11,250	3,750	15,000

Practice question **3**

X Ltd has budgeted fixed overheads of ₦6,000,000 for the next period.

X Ltd is preparing a budget to sell three products.

	P	Q	R	Total
Sales volumes (units)	10,000	6,000	4,000	20,000
Sales mix ratio	10	6	4	
Sales mix as %	50%	30%	20%	
Sales price per unit (₦)	250	400	1600	
Budgeted revenue (₦)	2,500,000	2,400,000	6,400,000	11,300,000
Contribution per unit (₦)	150	250	800	
Budgeted total contribution (₦)	1,500,000	1,500,000	3,200,000	6,200,000

Calculate the number of units that X Ltd must sell in order to break even and calculate the total revenue at that point.

Calculate the number of units of each item sold at break-even and the resulting revenue from each.

4.4 Margin of safety

The margin of safety is calculated in the same way as for single products by comparing the budgeted activity level to the break-even. The break-even point can be compared to the budgeted activity level using batches, units or revenue.

This will be illustrated using the previous example.

Example: Margin of safety

Continued….

Margin of safety

	Batches	Units	Revenue (₦)
Budgeted activity	5,000	20,000	2,100,000[1]
Break-even point	3,750	15,000	1,575,000
Margin of safety	1,250	5,000	525,000
Margin of safety as percentage of sales	25%	25%	25%

[1] Budgeted revenue = (₦100 × 15,000) + (₦120 × 5,000) = ₦2,100,000

4.5 Target profit

The target profit is calculated in the same way as for single products. The necessary contribution to earn the target profit is the target profit plus the fixed costs. The activity level required to achieve the necessary contribution may be found using contribution per unit, contribution per batch or the CS ratio.

This will be illustrated using the previous example.

Example: target profit

Continued….

The company wishes to make a profit of ₦189,000 on a fixed cost base of ₦315,000

Average contribution per batch	= ₦84
Average contribution per unit	= ₦21
Weighted average CS ratio	= 0.20

Target profit

	Batches	Units	Revenue
Target profit (₦189,000 + ₦315,000)	₦504,000	₦504,000	₦504,000
Contribution per batch	₦84		
Contribution per unit		₦21	
C/S ratio			÷0.20
	6,000	24,000	₦2,520,000
Sales (units) of X			
3 in each batch; or	18,000		
3 out of 4 units		18,000	
Sales (units) of Y			
1 in each batch; or	6,000		
1 out of 4 units		6,000	

Proof of revenue	**X**	**Y**	
Units to be sold	18,000	6,000	
Selling price per unit	100	120	
Revenue	1,800,000	720,000	₦2,520,000

4.6 Multi-product break-even charts

A break-even chart can be drawn for a company selling more than one product.

Such charts are usually drawn as a profit–volume graph.

The graph usually contains a plot of two lines:

- One line is based on the assumption that the most profitable good is sold first then the second most profitable and so on. This is a bow shaped line.
- The second line is based on the assumption that goods are sold in the budgeted mix. This is a straight line. Break-even is where this line crosses the horizontal axis.

The following steps must be taken in order to draw the graph:

Step 1: Calculate the C/S ratio of each product being sold.

Step 2: Rank the products in order of profitability.

Step 3: Draw a table showing the following:

Product (in order of profitability)	Revenue (from sales in this order)	Cumulative revenue	Contribution	Cumulative profit/(loss)
	nil	nil	nil	(fixed cost)
A	X	X	X	X
B	X	X	X	X
C	X	X	X	X

Step 4: Construct the graph as a plot of cumulative revenue against cumulative profit/(loss).

Example: Multi-product break-even chart

The following budget information refers to the two products of a company.

	X	Y	
Sales volume	15,000	5,000	
Sales price per unit	100	120	
Revenue	1,500,000	600,000	
Contribution per unit	25	9	
Contribution	375,000	45,000	
Fixed costs			315,000

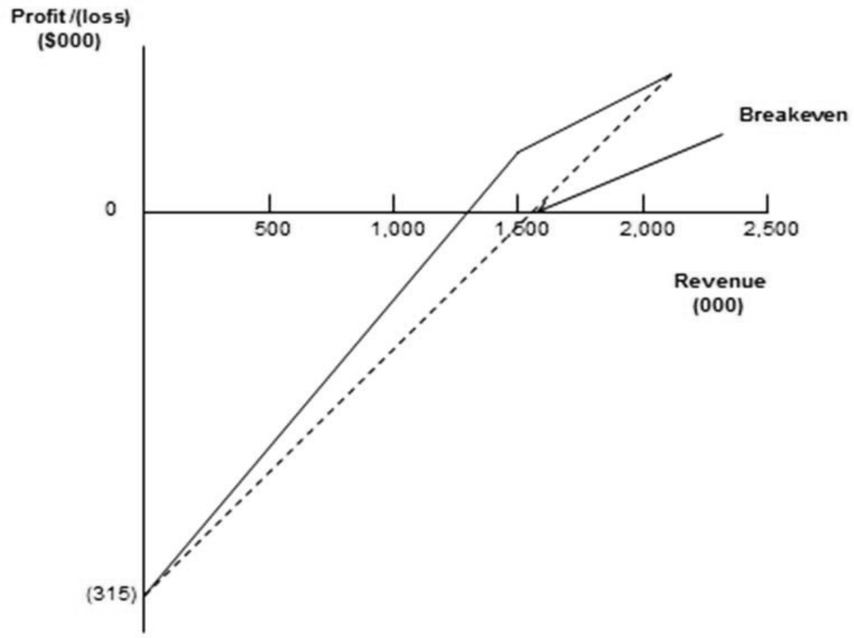
A profit volume chart to show the break-even point can be constructed as follows:

Step 1: C/S ratio	₦	₦
Sales price per unit	100	120
Contribution per unit	25	9
C/S ratio	0.25	0.075
Step 2: Ranking	1	2

Step 3: Profit volume chart

Product	Revenue	Cumulative revenue	Contribution	Cumulative profit or loss
				(315,000)
X	1,500,000	1,500,000	375,000	60,000
Y	600,000	2,100,000	45,000	105,000

This information can be plotted as follows:



5 IMPORTANCE AND WEAKNESSES OF CVP ANALYSIS

Section overview

- Introduction to multi-product break-even analysis
- Multi-product break-even analysis – weighted average unit approach
- Multi-product break-even analysis – Batch approach
- Margin of safety
- Target profit
- Multi-product break-even charts

5.1 Importance of CVP analysis

The profit made by an organisation is a function of sales volume, selling price, variable cost per unit and fixed costs.

CVP analysis provides a valuable insight into the relationship between costs, revenues and profit at various levels of activity. This can focus attention on those factors which might be controllable and which might have an impact on profit.

It allows a manager to understand the profit impact of decisions under consideration. For example, a manager could use the model to understand the profit impact of dropping selling price in order to try to increase sales volume (subject, of course, to the availability of information on the relationship between price and volume). Thus, CVP analysis can provide important information for:

- sales strategies;
- cost control; and
- decision making.

It allows managers to understand the minimum number of items that need to be sold (given the information about sales price and costs) in order to generate profit. This can be very useful when launching new products.

CVP analysis provides a focus on the effects of differing levels of activity on the financial results of a business. Production costs are often known with a degree of accuracy but sales volume is much more difficult to predict. It is relatively straight forward for managers to flex the model to show the possible impact of different sales volumes in the future.

5.2 Weaknesses of CVP analysis

CVP analysis rests on a series of simplifying assumptions. These assumptions are a weakness of the technique to the extent that they may not hold true in reality.

Assumptions	Comment
Costs are either fixed or variable and can be identified.	It can be difficult to classify costs as either fixed or variable. Some costs are semi-variable in nature.
The variable cost per unit is constant at all levels of output	This might be true over a given range but the analysis might provide answers outside the range. For example, the management might be confident of the variable cost per unit up to 10,000 units per annum but a target profit might require production of 15,000 units thus undermining the analysis. Variable cost per unit might be affected by the level of activity. For example, if a factory is operating near capacity it might be necessary to pay workers an overtime premium to fulfil new orders. On the other hand, the assumption ignores the possibility of possible economies of scale at higher levels of activity.
Total fixed costs are constant at all levels of output.	This might be true over a given range but the analysis might provide answers outside the range. This ignores the possibility of possible economies of scale at higher levels of activity.
The sales price per unit is constant for every unit of product sold.	Sales price is often adjusted to take account of market conditions. This would undermine decisions taken on the basis of the original analysis.
Companies make and sell a single product or several products in constant ratios to each other.	Neither of these assumptions would hold out in practice.

Furthermore, CVP analysis ignores the uncertainty inherent in the estimates of costs and revenues.

6 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Calculate the number of units that must be sold to achieve break-even
- Calculate the revenue that must be earned to achieve break-even
- Calculate the margin of safety associated with a given level of production in terms of the number of units sold or revenue
- Calculate the number of units that must be sold to achieve a target profit
- Calculate the revenue that must be earned to achieve a target profit

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

1 Contribution per unit = 60% × ₦80 = ₦48

Fixed costs = ₦360,000

Break-even point = ₦360,000/₦48 per unit = 7,500 units

Budgeted sales = 8,000 units

Margin of safety = (8,000 – 7,500) units = 500 units

As a percentage of budgeted sales, the margin of safety is (500/8,000) × 100% = 6.25%.

2 (a) Contribution/sales ratio = 60%

Therefore variable costs/sales ratio = 40%.

Variable cost per unit = ₦20

Therefore sales price per unit = ₦20/0.40 = ₦50.

Contribution per unit = ₦50 – ₦20 = ₦30.

	₦
Budgeted contribution (8,000 × ₦30)	240,000
Budgeted fixed costs (8,000 × ₦25)	200,000
Budgeted profit, current year	40,000

(b) Sales price next year = ₦50 × 1.06 = ₦53 per unit

Variable cost per unit next year = ₦20 × 1.05 = ₦21

Therefore contribution per unit next year = ₦53 – ₦21 = ₦32

	₦
Target profit next year	40,000
Fixed costs next year (200,000 × 1.10)	220,000
Target contribution for same profit as in the current year	260,000

Therefore target sales next year = ₦260,000/₦32 per unit = 8,125 units.

Solutions **1**

3 (a) Break-even point = ₦48,000/0.40 = ₦120,000 (sales revenue).

Margin of safety (in sales revenue) = ₦140,000 – ₦120,000 = ₦20,000.

Selling price per unit = ₦10.

Margin of safety (in units) = ₦20,000/₦10 = 2,000 units.

(b) (i) The margin of safety is 6.25%. Therefore the break-even volume of sales = 93.75% of budgeted sales = 0.9375 × ₦128,000 = ₦120,000

	Budget	**Break-even**
	₦	**₦**
Sales	128,000	120,000
Profit	2,000	0
Total costs	126,000	120,000

This gives us the information to calculate fixed and variable costs, using high/low analysis.

	₦ Revenue		**₦ Cost**
High: Total cost at	128,000	=	126,000
Low: Total cost at	120,000	=	120,000
Difference: Variable cost of	8,000	=	6,000

Therefore variable costs = ₦6,000/₦8,000 = 0.75 or 75% of sales revenue.

Substitute in high or low equation	**Cost**
	₦
Total cost at ₦128,000 revenue	126,000
Variable cost at ₦128,000 revenue (× 0.75)	96,000
Therefore fixed costs	30,000

Solution **1**

Alternative approach

3 (ii) At sales of ₦128,000, profit is ₦2,000.

The contribution/sales ratio = 100% – 75% = 25% or 0.25.

To increase profit by ₦3,000 to ₦5,000 each month, the increase in sales must be:

(Increase in profit and contribution) ÷ C/S ratio

= ₦3,000/0.25 = ₦12,000.

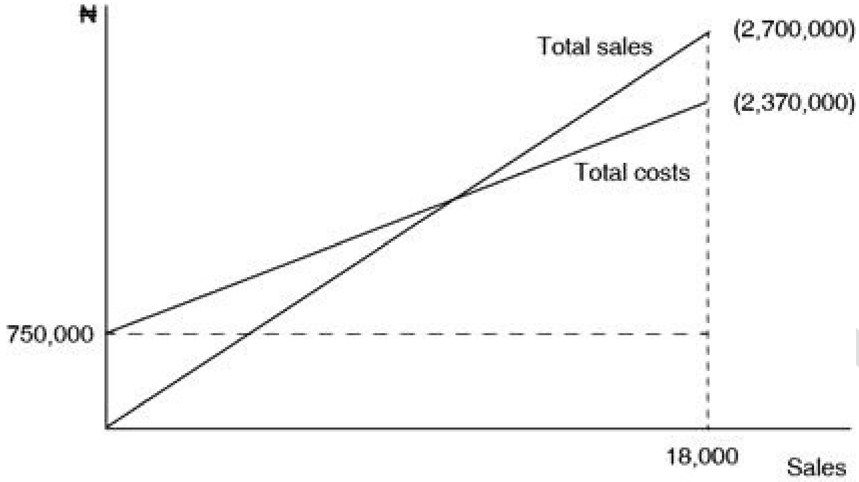
Sales must increase from ₦128,000 (by ₦12,000) to ₦140,000 each month.

Alternative approach to the answer

	₦
Target profit	5,000
Fixed costs	30,000
Target contribution	35,000
C/S ratio	0.25
Therefore sales required (₦35,000/0.25)	₦140,000

Solutions 2

(a)



Workings

	Sales	Sales (at ₦150)	Profit
	units	₦	₦
	18,000	2,700,000	330,000
	12,000	1,800,000	(30,000)
Difference	6,000	900,000	360,000

An increase in sales from 12,000 units to 18,000 units results in an increase of ₦900,000 in revenue and ₦360,000 in contribution and profit.

From this, we can calculate that the contribution is ₦60 per unit (₦360,000/6,000) and the C/S ratio is 0.40 (₦360,000/₦900,000). Variable costs are therefore 0.6 or 60% of sales.

To draw a break-even chart, we need to know the fixed costs.

Substitute in high or low equation

When sales are 18,000 units:	₦
Sales (at ₦150 each)	2,700,000
Variable cost (sales × 60%)	1,620,000
Contribution (sales × 40%)	1,080,000
Profit	330,000
Therefore fixed costs	750,000

When sales are 18,000 units:	₦
Fixed costs	750,000
Variable cost (see above)	1,620,000
Total costs	2,370,000

Solution (continued) **2**

(b) Break-even point = Fixed costs ÷ C/S ratio

= ₦750,000/0.40 = ₦1,875,000

Break-even point in units = ₦1,875,000/₦150 per unit = 12,500 units.

If budgeted sales are 15,000 units, the margin of safety is 2,500 units (15,000 – 12,500).

This is 1/6 or 16.7% of the budgeted sales volume.

Solutions **3**

The weighted average contribution per unit is:

₦6,200,000/20,000 units = ₦310 per unit

Break-even as a number of units is given by:

Fixed costs/Contribution per unit = ₦6,000,000/₦310 = 19,355 units

These units are in the ratio of 10:6:4 (or 50%: 30% 20%)

Therefore, the weighted average revenue per unit is:

₦11,300,000/20,000 units = ₦565 per unit

The break-even revenue is therefore 19,354.84 units × ₦565 = ₦10,935,485

The calculations of the sales volume of P, Q and R and the revenue from those sales can be calculated as follows:

	Units	P (50%)	Q (30%)	R (20%)
Break-even	19,355	9,677.5	5,806.5	3871
Revenue per unit		₦250	₦400	₦1,600
Revenue		₦2,419,355	₦2,322,581	₦6,193,549
Total revenue				₦10,935,485

Skills level
Performance management

CHAPTER 15

Limiting factors

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**			
	1	**Advanced decision-making and decision-support**		
		d	Apply key limiting factors in a given business scenario to:	
			i	Single constraint situation including make or buy

Exam context

This chapter explains the concept of limiting factors, how to identify them and how to formulate an optimum production plan when there is a single limiting factor.

Problems involving more than one limiting factors are solved using linear programming. This is covered in the next chapter.

By the end of this chapter, you should be able to:

- Explain the issue of limiting factors
- Identify limiting factors
- Carry out limiting factor analysis to formulate an optimal production plan (i.e. the production plan that maximises contribution and hence profit) in circumstances where there is a single limiting factor

1 COSTS FOR DECISION MAKING

Section overview

- Management information for making decisions
- Using marginal costing 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.

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

- Information about costs and revenues 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.

A useful definition of relevant costs and revenues is as follows:

Definition

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.

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 following assumptions:

- The objective is to maximise profit and this is achieved by maximising contribution;
- marginal costs (variable costs) are the only relevant costs to consider in the model: and
- fixed costs will be the same whatever decision is taken; therefore fixed costs are not relevant to the decision.

2 LIMITING FACTOR DECISIONS

Section overview

- Limiting factor: the issue
- Identifying limiting factors
- Maximising profit when there is a single limiting factor

2.1 Limiting factor: the issue

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.

Definition: Limiting factor

This is the item that restricts or constraints the production or sale of a product or service.

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 Identifying limiting factors

A question might tell you that there is a restricted supply of a resource without telling you which one it is.

In this case you must 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: Identifying a limiting factor

A company manufactures and sells two products, Product X and Product Y which are both manufactured using two different machines.

The time taken to make each product together with the maximum machine time availability and contribution per unit and demands are as follows:

Product	X	Y	Hours available
Machine type 1	10 minutes per unit (6 per hour)	6 minutes per unit (10 per hour)	3,000 hours
Machine type 2	5 minutes per unit (12 per hour)	12 minutes per unit (5 per hour)	4,200 hours
Sales demand in units	12,000	15,000	

Which machine is the limiting factor is identified by calculating the time needed to meet the total demands for both goods and comparing that to the machine time available:

	Machine type 1 (hours)	Machine type 2 (hours)
12,000 ÷ 6 per hour	2,000	
12,000 ÷ 12 per hour		1,000
Making 15,000 units of Y would use:		
15,000 ÷ 10 per hour	1,500	
15,000 ÷ 5 per hour		3,000
Total hours needed to meet maximum demand	3,500	4,000
Total hours available	3,000	4,200

Therefore, machine 1 time is the limiting factor

2.3 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 approach is to select products for manufacture and sale according to the contribution per unit of scarce resource in that product.

Step 1: Calculate the contribution per unit of each type of good produced.

Step 2: Identify the scarce resource.

Step 3: Calculate the amount of scarce resource used by each type of product.

Step 4: Divide the contribution earned by the scarce resource used by that product (project or item of goods) to give the contribution per unit of scarce resource for that product (project or item of goods).

Step 5: Rank the products (projects or items of goods) in order of the contribution per unit of scarce resource.

Step 6: Construct a production plan based on this ranking. The planned output and sales are decided by working down through the priority list until all the units of the limiting factor (scarce resource) have been used.

Example: Limiting factor analysis

A company manufactures and sells two products, Product X and Product Y which are both manufactured using two different machines.

The time taken to make each product together with the maximum machine time availability and contribution per unit and demands are as follows:

Product	X	Y	Hours available
Machine type 1	10 minutes per unit (6 per hour)	6 minutes per unit (10 per hour)	3,000 hours
Machine type 2	5 minutes per unit (12 per hour)	12 minutes per unit (5 per hour)	4,200 hours
Contribution per unit	₦7	₦5	
Sales demand in units	12,000	15,000	

Given that machine 1 is a limiting factor the optimal production plan (that which maximises annual contribution and hence profit) can be found as follows:

Step 1: Calculate the contribution per unit of goods produced (given)

Step 2: Identify scarce resource (given as machine 1 in this case)

Step 3: Calculate the amount of scarce resource used to make each type of product (given in this case)

Example (continued): Limiting factor analysis

Step 4: Contribution per unit of scarce resource (machine time)

Product	X	Y
Contribution per unit	₦7	₦5
Machine type 1 time per unit	10 minutes	6 minutes
Contribution per hour (Machine type 1)	₦42	₦50
Step 5: Ranking	2nd	1st

The products should be made and sold in the order Y and then X, up to the total sales demand for each product and until the available machine 1 time is used completely.

Step 6: Construct a production plan to maximise contribution

Product	Sales units	Machine 1 hours used	Contribution per unit	Total contribution
			₦	₦
Y (1st)	15,000 (maximum)	1,500	5	75,000
X (2nd)	9,000	1,500 (balance)	7	63,000
		3,000		138,000

Note: The plan is constructed as follows.

Y is ranked first so the company needs to make as many of these as possible. The most in can sell is 15,000 units which would take 1,500 hours (10 per hour) to make. The company has 3,000 hours available so all of these can be made.

The company now has 1,500 hours left. X is ranked second and the most of X that can be sold is 12,000 units. This would use 2,000 hours (6 per hour). This means that only 9,000 units of X can be made (found as 1,500 units at 6 per hour or 12,000 units × $^{1,500\text{ hours}}/_{2,000\text{ hours}}$).

Practice question **1**

A company makes four products, A, B, C and D, using the same direct labour work force on all the products.

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.

Only 6,000 direct labour hours are available during the year.

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

Calculate the optimal production plan

Practice question **2**

A company makes four products, W, X, Y and Z, using the same direct material in the manufacture of all the products.

Budgeted data for one month is as follows:

Product	**W**	**X**	**Y**	**Z**
Monthly sales demand (units)	400	400	600	300
	₦	₦	₦	₦
Direct materials cost	500	400	800	600
Direct labour cost	400	600	300	500
Variable overhead	100	150	75	125
Fixed overhead	800	1200	600	1,000
Full cost	1,800	2,350	1,775	2,225
Sales price	5,000	3,150	5,975	5,425
Profit per unit	3,200	800	4,200	3,200

Due to restricted supply, only ₦780,000 of direct materials will be available during the month.

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

Tutorial note

This question does not tell you the amount of material but it does give you its value. The analysis can proceed in the usual way using contribution per value of material rather than contribution per amount of material.

3 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the issue of limiting factors
- Identify limiting factors
- Carry out limiting factor analysis to formulate an optimal production plan (i.e. the production plan that maximises contribution and hence profit) in circumstances where there is a single limiting factor

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

Step 1: Calculate the contribution per unit of goods produced

Product	**A**	**B**	**C**	**D**
Sales price	15.5	29.0	11.5	27.0
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
Variable cost per unit	(11.0)	(22.0)	(9.0)	(18.0)
Contribution per unit	4.5	7.0	2.5	9.0

Step 2: Identify scarce resource (given as labour in this case)

Step 3: Labour hours per unit

(total labour cost/labour cost per hour)	6/12	12/12	3/12	9/12
	0.5	1	0.25	0.75

Step 4: Contribution per hour

(contribution per unit/ labour hours per unit	4.5/0.5	7/1	2.5/0.25	9/0.75
Contribution per hour (₦)	9	7	10	12

Step 5: Ranking	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

Step 6: Construct a production plan to maximise contribution

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

Solution (continued) **1**

Note: The plan is constructed as follows:

D is ranked first so the company needs to make as many of these as possible. The most it can sell is 4,000 units which would take 3,000 hours (0.75 hours per unit) to make. The company has 6,000 hours available so all of these can be made.

The company now has 3,000 hours left. C is ranked second and the most of C that can be sold is 8,000 units. This would use 2,000 hours (0.25 hours per unit).

The company now has 1,000 hours left. A is ranked third and the most of these that can be sold is 4,000 units. However, this would use 2,000 hours (0.5 hours per unit) so only half of these can be made.

Solution **2**

	W	X	Y	Z
	₦	₦	₦	₦
Sales price/unit	5,000	3,150	5,975	5,425
Variable cost/unit	1,000	1,150	1,175	1,225
Contribution per unit	4,000	2,000	4,800	4,200
Direct materials per unit (₦)	500	400	800	600
₦ 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	**Direct materials**	**Sales units**	**Contribution per unit**	**Total contribution**
	₦		₦	₦
W (1st)	200,000	400	4,000	1,600,000
Z (2nd)	180,000	300	4,200	1,260,000
Y (3rd) - balance	400,000	500	4,800	2,400,000
	780,000			5,260,000

Skills level
Performance management

CHAPTER 16

Linear programming

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**			
	1	**Advanced decision-making and decision-support**		
		d	Apply key limiting factors in a given business scenario to:	
			ii	Multiple constraint situations involving linear programming using simultaneous equations, graphical techniques and simplex method. (The simplex method is limited to formulation of initial tableau and interpretation of final tableau).
				NB. Computation and interpretation of shadow prices are also required.

Exam context

This chapter explains linear programming, a technique concerned with the use of scarce resources among various competing activities in such a way as to maximise (or minimise) the outcome expressed as a given objective.

Section 1 of this chapter explains linear inequalities and how they might be plotted in a coordinate system. This is done by changing them to linear equalities by plotting them at the maximum (or minimum) values they can achieve. Once plotted the linear inequalities define a region in which all feasible solutions must be. Anything outside this feasible region is not possible.

Section 2 shows how this concept can be extended into problem solving. It shows how to identify constraints and how to plot them to establish a feasible region. It continues by explaining several methods of establishing the optimal point on this region.

Section 3 extends linear programming into practical business problems.

By the end of this chapter, you should be able to:

- Explain the basic concepts of linear programming
- Explain the meaning of objective function and constraints in linear programming
- Formulate a linear programmes
- Solve linear programming problems to identify the optimal solution when there is more than one constraint

1 LINEAR PROGRAMMING

Section overview

- Two or more limiting factors
- Formulating constraints
- Plotting constraints

1.1 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.

Linear programming is a mathematical method for determining a way to achieve the best outcome (such as maximum profit or lowest cost) subject to a number of limiting factors (constraints).

- A linear programming problem involves maximising or minimising a linear function (the objective function) subject to linear constraints.
- Both the constraints and the "best outcome" are represented as linear relationships.

What constitutes the best outcome depends on the objective. The equation constructed to represent the best outcome is known as the objective function.

Typical examples would be to work out the maximum profit from making two sorts of goods when resources needed to make the goods are limited or the minimum cost for which two different projects are completed.

Overall approach

Formulate the problem:

- **Step 1:** Define variables.
- **Step 2:** Formulate the objective function
- **Step 3:** Formulate the constraints.

Solve the problem:

Step 4: Plot the constraints on a graph

Step 5: Identify the feasible region. This is an area that represents the combinations of x and y that are possible in the light of the constraints.

Step 6: Identify the values of ***x*** and ***y*** that lead to the optimum value of the objective function. This might be a maximum or minimum value depending on the objective. There are different methods available to find this combination of values of ***x*** and ***y***.

This chapter will firstly discuss some of the above steps in a little more detail before continuing to demonstrate their full use to solve a problem.

1.2 Formulating constraints

Define variables

The first step in any formulation is to define variables for the outcome that you are trying to optimise. For example, if the question is about which combination of products will maximise profit, a variable must be defined for the number of each type of product in the final solution.

The defined variable can then be sued to formulate the objective function and constraints. This section is going to say a little more about the formulation of constraints.

Construct constraints

A separate constraint must be identified 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.

- For a **maximum limit**, the constraint must be expressed as ‘must be equal to or less than’.
- For a **minimum limit**, the constraint must be expressed as ‘must be equal to or more than’.

Example: Formulate constraints – maximum demand

Type of constraint	**Illustration**
Maximum limit:	Maximum sales demand for Product X of 5,000 units
Define variables	Let x be the number of Product X made.
Constraint expressed as:	$x \leq 5,000$

Example: Formulate constraints – Constraints with two variables

Type of constraint	**Illustration**
Constraints with two variables	A company makes two products, X and Y. It takes 2 hours to make one unit of X and 3 hours to make one unit of Y. Only 18,000 direct labour hours are available.
Define variables	Let x be the number of Product X made and let y be the number of Product Y made.
Constraint expressed as:	$2x + 3y \leq 18,000$

Example: Formulate constraints – Minimum production allowed

Type of constraint	Illustration
Minimum limit:	There is a requirement to supply a customer with at least 2,000 units of Product X
Define variables	Let x be the number of Product X made.
Constraint expressed as:	$x \geq 2,000$

Example: Formulate constraints – Non-negativity

Type of constraint	Illustration
Non-negativity constraints	It is not possible to make a negative number of products.
Define variables	Let x be the number of Product X made and let y be the number of Product Y made.
Constraint expressed as:	$x, y \geq 0$ are called positive constraints
	These constraints do not have to be plotted as they are the x and y axes of the graph

1.3 Plotting constraints

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).

Example: Constraints

Constraint	Outer limit represented by the line
$2x + 3y \leq 600$	$2x + 3y = 600$
	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. Two points are needed to draw a straight line on a graph. The easiest approach to finding the points is to set x to zero and calculate a value for y and then set y to zero and calculate a value for x.

Example: Plotting a constraint

$2x + 3y = 600$

when $x = 0$, $y = 200$ (600/3)

when $y = 0$, $x = 300$ (600/2)

Joining these two points results in a line showing the values of x and y that are the maximum possible combined values that meet the requirements of the constraint

2 LINEAR PROGRAMMING OF BUSINESS PROBLEMS

Section overview

- Introduction
- Maximising (or minimising) the objective function
- Slope of the objective function
- Simultaneous equations
- Minimising functions

2.1 Introduction

Decisions about what mix of products should be made and sold in order to maximise profits can be formulated and solved as linear programming problems.

Overall approach (repeated here for your convenience)

- ❑ **Step 1:** Define variables.
- ❑ **Step 2:** Formulate the objective function
- ❑ **Step 3:** Formulate the constraints.

Step 4: Plot the constraints on a graph

Step 5: Identify the feasible region. This is an area that represents the combinations of x and y that are possible in the light of the constraints.

Step 6: Identify the values of ***x*** and ***y*** that lead to the optimum value of the objective function. This might be a maximum or minimum value depending on the objective. There are different methods available to find this combination of values of ***x*** and ***y***.

Example: Linear programme

A company makes and sells two products, Product X and Product Y.

The following information is relevant:

	Product X	Product Y
Direct labour hours per unit	6 hours	3 hours
Materials per unit	4 kgs	8 kgs

Resource availability (per hour):	
Total direct labour hours available (there being more than one worker)	36 hrs
Total material available	48 kg

In addition, the company must make at least 2 units of product X and 3 units of Product Y every hour

What combination of Product X and Product Y per hour will maximise contribution per hour?

Example continued: Linear programme

Step 1: Define the variables

Let x equal the number of units of Product X made

Let y equal the number of units of Product Y made

Step 2: Formulate the objective function

The objective is to maximise contribution given by: $C = 50x + 40y$

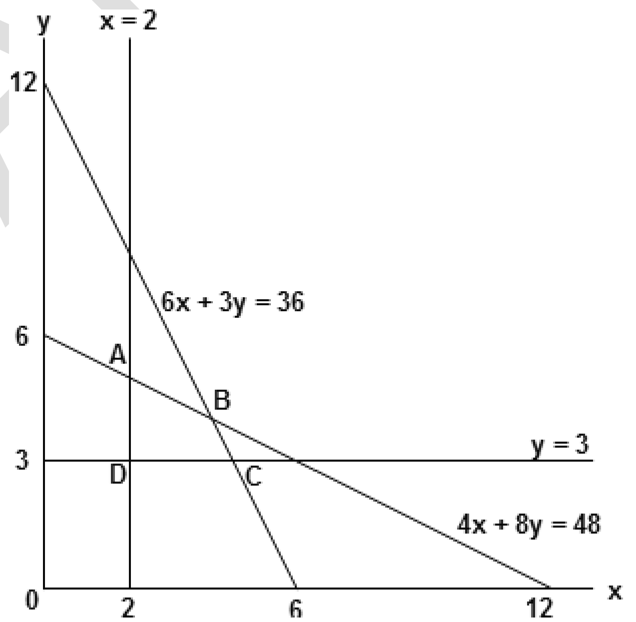
Step 3: Formulate the constraints

Constraint:

Labour hours	$6x + 3y \leq 36$
	Whatever value is found for x and y, the maximum value that 6x + 3y can have is 36.
Material	$4x + 8y \leq 48$
	Whatever value is found for x and y, maximum value that 4x + 8y can have is 48
Minimum production:	$x \geq 2$ (x must be at least 2)
	$y \geq 3$ (y must be at least 3)

Step 4: Plot the constraints

$6x + 3y = 36$	if x = 0 then y = 12 and if y = 0 then x = 6
$4x + 8y = 48$	if x = 0 then y = 6 and if y = 0 then x = 12



Example: Linear programme

Step 5: Identify the feasible region

The feasible area for a solution to the problem is shown as the area ABCD.

Any 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.

2.2 Maximising (or minimising) the objective function

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.

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.

The solution is a combination of values for ***x*** and ***y*** that lies at one of the 'corners' of the outer edge of the feasible area. In the graph above, the solution to the problem will be the values of ***x*** and ***y*** at A, B or C. The optimal solution cannot be at D as the objective function is maximisation and values of ***x*** and/or ***y*** are higher than those at D for each of the other points.

The optimal combination of values of ***x*** and ***y*** can be found using one of the following:

- corner point theorem;
- slope of the objective function: or
- simultaneous equations.

Each of these will be demonstrated in turn but the simultaneous equation approach is by far the most commonly used.

Corner point theorem

The optimum solution lies at a corner of the feasible region. The approach involves calculating the value of ***x*** and ***y*** at each point and then substituting those values into the objective function to identify the optimum solution.

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

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 for each.

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

Example: Linear programme – Optimum solution using corner point theorem (continued).

The maximum value the objective function could take will be at either A or B or C

Point A is at the intersection of:	x = 2	1
	4x + 8y = 48	2
Substitute for x in equation 2	4(2) + 8y = 48	
	8y = 48 – 8	
	y = 5	
Point B is at the intersection of:	4x + 8y = 48	1
	6x + 3y = 36	2
Multiply equation 1 buy 1.5	6x + 12y = 72	3
Subtract 2 from 3	9y = 36	
Therefore	y = 4	
Substitute for y in equation 1	4x +8(4) = 48	
	4x = 16	
	x = 4	
Point C is at the intersection of:	y = 3	1
	6x + 3y = 36	2
Substitute for y in equation 2	6x + 3(3) = 36	
	6x = 27	
	x = 4.5	
Substitute coordinates into objective function		
	C = 50x + 40y	
Point A (x = 2; y = 5)	C = 50(2) + 40(5)	
	C = 300	
Point B (x = 4; y = 4)	C = 50(4) + 40(4)	
	C = 360	
Point C (x = 4.5; y = 3)	C = 50(4.5) + 40(3)	
	C = 345	

Conclusion: The optimal solution is at point B where x = 4 and y = 4 giving a value for the objective function of 360.

2.3 Slope of the objective function

There are two ways of using the slope of the objective line to find the optimum solution.

Measuring slopes

This approach involves estimating the slope of each constraint and the objective function and ranking them in order. The slope of the objective function will lie between those of two of the constraints. The optimum solution lies at the intersection of these two lines and the values of x and y at this point can be found as above.

Example: Optimum solution by measuring slopes

Objective function:	Rearranged	Slope
C = 50x + 40y	$y = C/40 - 1.25x$	– 1.25
Constraints:		
6x + 3y = 36	y = 12 – 2x	– 2
4x + 8y = 48	y = 6 – 0.5x	– 0.5
x = 2		∞
y = 3		0

The slope of the objective function (– 1.25) lies between the slopes of 6x + 3y = 36 (– 2) and 4x + 8y = 48 (– 0.5). The optimum solution is at the intersection of these two lines.

Values of x and y at this point would then be calculated as above (x = 4 and y = 4) and the value of the objective function found.

Plotting the objective function line and moving it from the source

The example above showed that the objective function (C = 50x + 40y) can be rearranged to the standard form of the equation of a straight line (y = C/40 − 1.25x).

This shows that the slope of the line is not affected by the value of the equation (C). This is useful to know as it means that we can set the equation to any value in order to plot the line of the objective function on the graph.

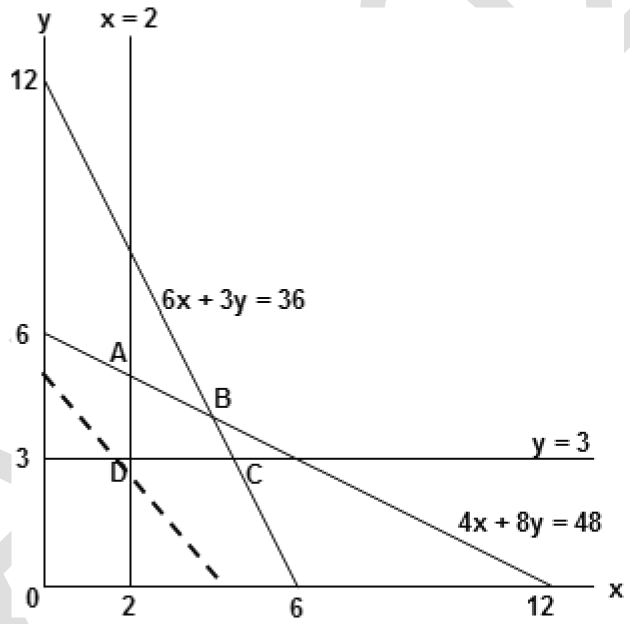
The first step is to pick a value for the objective function and construct two pairs of coordinates so that the line of the objective function can be plotted. (The total value of the line does not matter as it does not affect the slope and that is what we are interested in).

Example: Plotting the objective function (C = 50x + 40y)

Let C = 200

200 = 50x + 40y if x = 0 then y = 5 and if y = 0 then x = 4

This is plotted as the dotted line below.



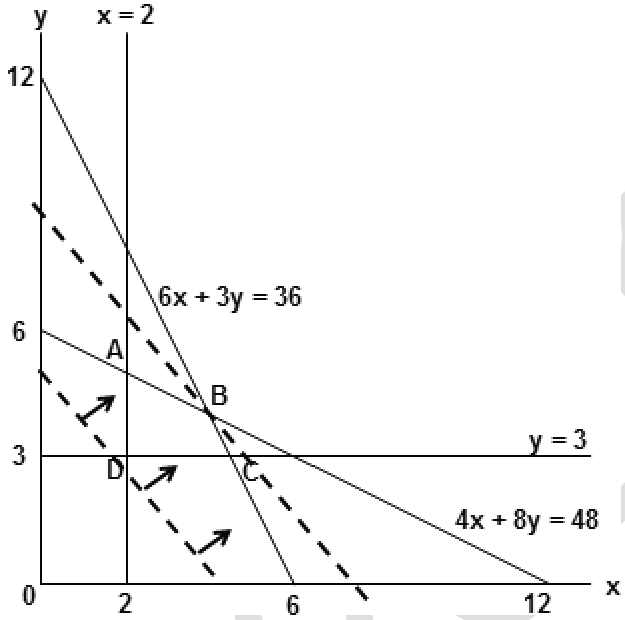
Note that the value of C in the above plot of the objective function is constant (at 200). This means that any pair of values of x and y that fall on the line will result in the same value for the objective function (200). If a value higher than 200 had been used to plot the objective function it would have resulted in a line with the same slope but further out from the source (the intersection of the x and y axes).

We are trying to maximise the value of the objective function so the next step is to identify the point in the feasible area where objective function line can be drawn as far from the origin of the graph as possible.

This can be done by putting a ruler along the objective function line that you have drawn and moving it outwards, parallel to the line drawn, until that point where it just leaves the feasible area. This will be one of the corners of the feasible region. This is the combination of values of x and y that provides the solution to the linear programming problem.

Example: Finding the optimum solution

Move a line parallel to the one that you have drawn until that point where it is just about to leave the feasible region.



The optimum solution is at point B (as before). This is at the intersection of 6x + 3y = 36 and 4x + 8y = 48.

The values of x and y can then be read off the graph and inserted into the objective function. If the graph had been drawn accurately this approach would give the same values for x and y as already found (i.e. x = 4 and y = 4).

2.4 Simultaneous equations

Instead of reading the values of x and y at which the objective function is maximised off a graph they could be found by solving the equations of the lines simultaneously.

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 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:

Example: Finding the optimum solution

Solving for values of x and y at the intersection of two lines.

(1) $6x + 3y = 36$

(2) $4x + 8y = 48$

		Equation
	$6x + 3y = 36$	1
	$4x + 8y = 48$	2
Multiply equation 2 by 1.5 (to make the y coefficients the same)	$6x + 12y = 72$	3
Subtract equation 1 from equation 3:		
From above	$6x + 3y = 36$	1
Therefore	$9y = 36$	3
	$\mathbf{y = 4}$	
Substitute y = 4 into equation 1	$6x + 3y = 36$	1
	$6x + (3 \times 4) = 36$	
	$6x = 36 - 12$	
	$6x = 24$	
	$\mathbf{x = 4}$	

Conclusion: Contribution is maximised at the intersection of line 6x + 3y = 36 and 4x + 8y = 48 giving a solution of x = 4 and y = 4.

The value of the objective function at this point is:

$$C = 50x + 40y$$

$$C = (50 \times 4) + (40 \times 4) = 360$$

2.5 Minimising functions

The above illustration is one where the objective is to maximise the objective function. For example, this might relate to the combination of products that maximise profit.

You may also face minimisation problems (for example, where the objective is to minimise costs). In this case the optimal solution is at the point in the feasible region that is closest to the origin. It is found using similar techniques to those above.

Practice question **1**

Solve the following linear programme.

Objective function: Maximise C = 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

Practice question **2**

Construct the constraints and the objective function taking into account the following information:

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.

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

	Total hours
Total direct labour hours available	20,000
Total machine hours available	12,000

Practice question **3**

Lagos Manufacturing Limited makes and sells two versions of a product, Mark 1 and Mark 2

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.

	Mark 1	**Mark 2**
Direct materials per unit	2 kgs	4 kgs
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

	Resource available
Direct materials	24,000 kgs
Direct labour hours	18,000 hours

3 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the basic concepts of linear programming
- Explain the meaning of objective function and constraints in linear programming
- Formulate a linear programme
- Solve linear programming problems to identify the optimal solution when there is more than one constraint

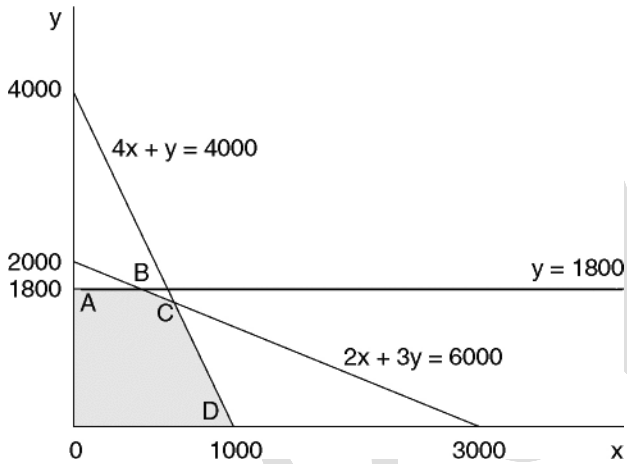
SOLUTIONS TO PRACTICE QUESTIONS

Solution – Plotting the constraints **1**

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 $y = 0$, $x = 3{,}000$.

(2) Constraint: $4x + y = 4{,}000$
When $x = 0$, $y = 4{,}000$. When $y = 0$, $x = 1{,}000$.

(3) Constraint : $y = 1{,}800$

The feasible area for a solution to the problem is shown as the shaded area OABCD.

Solution – Plotting the objective function and identifying the optimum point. **1**

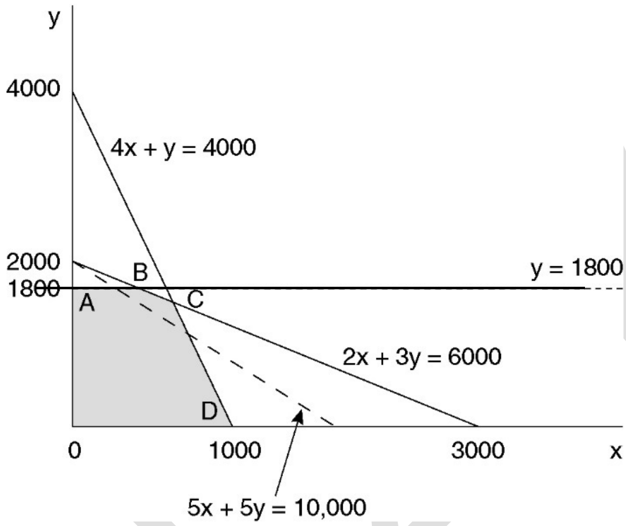
Plotting the objective function – Let P = 10,000 (The value 10,000 is chosen as a convenient multiple of the values 5 and 5 that can be drawn clearly on the graph.)

5x + 5y = 10,000

x = 0, y = 2,000 and y = 0, x = 2,000.

The combination of values of x and y that will maximise total contribution lies at point C on the graph.

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



Solution – Solving the values of x and y that maximise the objective function and finding its maximum value **1**

The optimum solution is at point C. This can be found be examining the objective function line to see where it leaves the feasible region, using corner point theorem or by comparing the slope of the objective function to the slopes of the constraints (workings given on next page)

Point C is at the intersection of: 2x + 3y = 6,000 and 4x + y = 4,000

Solving for x and y:

	2x + 3y	=	6,000	1
	4x + y	=	4,000	2
Multiply (1) by 2:	4x + 6y	=	12,000	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 objective function is maximised by producing 600 units of X and 1,600 units of Y.

The objective in this problem is to maximise 5x + 5y giving a maximum value of:

5 (600) + 5 (1,600) = 11,000.

Solution – Optimum solution using corner point theorem. **1**

Maximise C = 5x + 5y

Point A is where	y = 1,800	
	x = 0	
Point B is at the intersection of:	y = 1,800	1
	2x + 3y = 6,000	2
	2x + 3(1,800) = 6,000	3
	x = 300	
Point C is at the intersection of:	2x + 3y = 6,000	1
	4x + y = 4,000	2
Solved previously at	x = 600 and y = 1,600	
Point D is at the intersection of:	y = 0	1
	4x + y = 4,000	2
	4x + 0 = 4,000	
	x = 1,000	

Substitute coordinates into objective function

	C = 5x + 5y
Point A (x = 0; y = 1,800)	C = 5(0) + 5(1,800)
	C = 9,000
Point B (x = 300; y = 1,800)	C = 5(300) + 5(1,800)
	C = 10,500
Point C (x = 600; y = 1,600	C = 5(600) + 5(1,600)
	C = 11,000
Point D (x = 1,000; y = 0)	C = 5(1,000) + 5(0)
	C = 5,000

Conclusion: The optimal solution is at point C where x = 600 and y = 1,600 giving a value for the objective function of 11,000.

Solution – Optimum solution by measuring slopes **1**

Objective function:	Rearranged	Slope
$C = 5x + 5y$	$y = {}^{C}/_{5} – x$	– 1
Constraints:		
$y = 1,800$		0
$2x + 3y = 6,000$	$y = 2,000 – {}^{2}/_{3}x$	$– {}^{2}/_{3}$
$4x + y = 4,000$	$y = 1,000 – 4x$	– 4

The slope of the objective function (– 1) lies between the slopes of 2x + 3y = 6,000 ($– {}^{2}/_{3}$) and 4x + y = 4,000 (– 4). The optimum solution is at the intersection of these two lines.

Values of x and y at this point have been calculated above.

Solutions **2**

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 given as C = 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

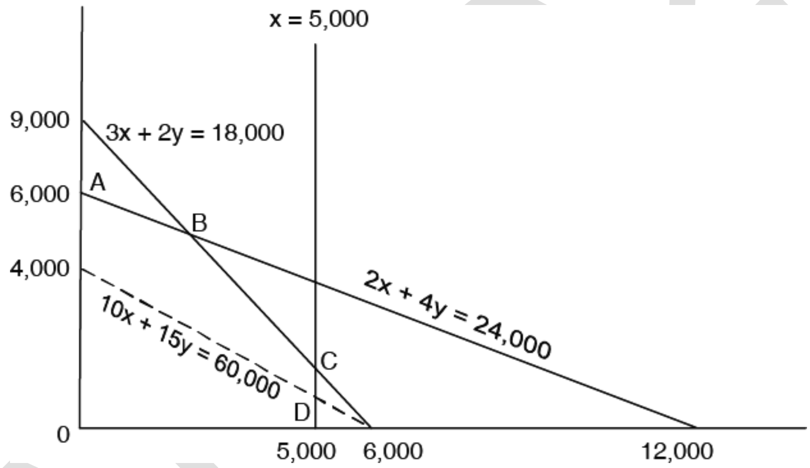
Solution **3**

Define the constraints	Let the number of units of Mark 1 be x
	Let the number of units of Mark 2 be y.
Formulate the objective function:	Maximise total contribution given by: C = 10x + 15y
	Let C = 60,000 to allow a plot of the line

Formulate 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

Plot the constraints and objective function:



The feasible solutions are shown by the area 0ABCD in the graph.

Solution – Solving the values of x and y that maximise the objective function and finding its maximum value **3**

The optimum solution is at point B. This can be found be examining the contribution line to see where it leaves the feasible region, using corner point theorem or by comparing the slope of the objective function to the slopes of the constraints (workings given on next page)

Point B is at the intersection of: 2x + 4y = 24,000 and 3x + 2y = 18,000

Solving for x and y:

	2x + 4y	=	24,000	1
	3x + 2y	=	18,000	2
Multiply (1) by 2:	6x + 4y	=	36,000	3
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 total contribution is maximised by producing 3,000 units of X and 4,500 units of Y.

The objective in this problem is to maximise 10x + 15y giving a maximum value of:

10 (3,000) + 15 (4,500) = 97,500.

Solution – Optimum solution by measuring slopes. **3**

Objective function:	Rearranged	Slope
C = 10x + 15y	$y = {}^{C}/_{15} - {}^{10}/_{15}x$	$-{}^{10}/_{15} = -{}^{2}/_{3}$
Constraints:		
2x + 4y = 24,000	y = 6,000 – 0.5x	– 0.5x
3x + 2y = 18,000	$y = 9,000 - {}^{3}/_{2}x$	$-{}^{3}/_{2}$
x = 5,000		∞

The slope of the objective function ($-{}^{2}/_{3}$) lies between the slopes of 2x + 4y = 24,000 (– 0.5) and 3x + 2y = 18,000 ($-{}^{3}/_{2}$). The optimum solution is at the intersection of these two lines.

Values of x and y at this point would then be calculated as above (x = 3,000 and y = 4,500) and the value of the objective function found.

Solution – Optimum solution using corner point theorem. **3**

Maximise C = 10x + 15y

Point A is where	y = 6,000	
	x = 0	
Point B is at the intersection of:	2x + 4y = 24,000	
	3x + 2y = 18,000	
Solved previously at	x = 3,000 and y = 4,500	
Point C is at the intersection of:	x = 5,000	1
	3x + 2y = 18,000	2
Substituting	3(5,000) + 2y = 18,000	
	y = 1500	
Point D is where	y = 0	
	x = 5,000	

Substitute coordinates into objective function

	C = 10x + 15y
Point A (x = 6,000; y = 0)	C = 10(0) + 15(6,000)
	C = 90,000
Point B (x = 3,000; y = 4,500)	C = 10(3,000) + 15(4,500)
	C = 97,500
Point C (x = 5,000; y = 1,500)	C = 10(5,000) + 15(1,500)
	C = 72,500
Point D (x = 5,000; y = 0)	C = 10(5,000) + 15(0)
	C = 50,000

Conclusion: The optimal solution is at point B where x = 3,000 and y = 4,500 giving a value for the objective function of 97,500.

Skills level
Performance management

CHAPTER 17

Further aspects of linear programming

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**			
	1	**Advanced decision-making and decision-support**		
		d	Apply key limiting factors in a given business scenario to:	
			ii	Multiple constraint situations involving linear programming using simultaneous equations, graphical techniques and simplex method. (The simplex method is limited to formulation of initial tableau and interpretation of final tableau).
				NB. Computation and interpretation of shadow prices are also required.

Exam context

The previous chapter explained the basic linear programming technique.

This chapter takes the technique further in two areas.

Further aspects of linear programming

Section 1 of this chapter is about the dual price. This is the change in value of the objective function which arises from a change in availability of scarce resource. It is usually expressed as the increase in the objective function arising from the increase of one extra unit of a scarce resource.

Section 2 explains the simplex method. This is illustrated using the same basic example that was used in the previous chapter. It is quite complicated and you could be forgiven for asking "why bother when we already have a perfectly good technique?" The reason is that simplex can be used to solve linear programming problems where there are more than two variables.

By the end of this chapter, you should be able to:

- Calculate the dual price and explain what it means
- Set up the initial tableau for simplex
- Transform the tableau to a solution
- Interpret the final tableau

1 DUAL PRICES AND SLACK VARIABLES

Section overview

- Introduction to dual prices
- Calculating dual prices
- Dual prices and business problems
- Limit to the dual price
- Slack

1.1 Introduction to dual prices

Linear programming is a method of solving for the optimum solution of a linear function subject to constraints identified as other linear functions. Some constraints are limiting but others are non-limiting.

Every constraint has a dual price (also known as the shadow price). The dual price of a constraint is the change in the objective function that is brought about if a constraint is changed by a unit.

The dual price of a non-limiting constraint is zero. This should be obvious. If a constraint is non-limiting, a small increase or decrease in its availability will have no impact on the value of the objective function.

Dual prices of limiting resources always have a value. This may be positive or negative depending on whether it is calculated by reducing or increasing availability of a resource and whether a problem is maximising or minimising.

1.2 Calculating dual prices

Once the solution is found to a linear programme, it is easy to calculate dual prices.

Dual prices are calculated one at a time by taking the following steps:

- Increase the limit of the first limiting constraint by one unit.
- Recalculate values for the variables.
- Recalculate the value of the objective function and compare the new figure to the value of the objective function in the original solution.

The difference is the dual price of the constraint.

This process is then repeated for the other constraint.

This is illustrated below using information from an earlier example which is repeated here for your convenience.

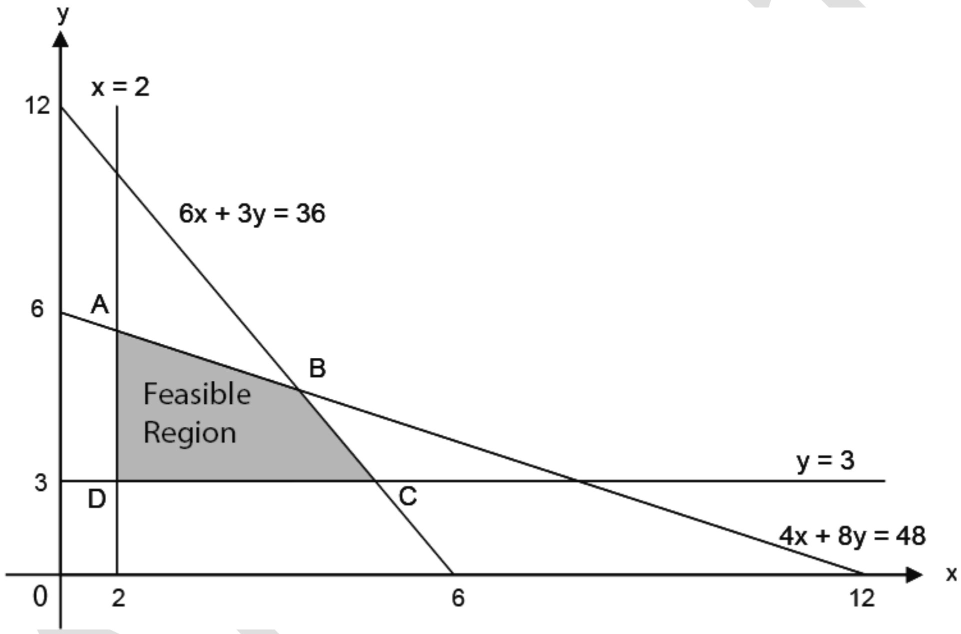
Example: Linear programme

Maximise $C = 50x + 40y$

Subject to the constraints

$6x + 3y \leq 36$	Constraint 1
$4x + 8y \leq 48$	Constraint 2
$x \geq 2$	x must be at least 2
$y \geq 3$	y must be at least 3

Plot the constraints



Optimum solution is at point B

Point B is at the intersection of		$4x + 8y = 48$	1
	and	$6x + 3y = 36$	2
Multiply equation 1 by 1.5		$6x + 12y = 72$	3
Subtract 2 from 3		$9y = 36$	
		$y = 4$	
Substitute for y in equation 1		$4x + 8(4) = 48$	
		$4x = 16$	
		$x = 4$	

Conclusion: The optimal solution is at point B where x = 4 and y = 4 giving a value for the objective function of 360.

Point B is where x = 4 and y = 4 $\therefore C = 50(4) + 40(4)$

$C = 360$

Example: Linear programme – dual price

Constraint 1

Increase the value of constraint 1 by 1

Point B is at the intersection of		$4x + 8y = 48$	1
	and	$6x + 3y = 37$	2
Multiply equation 1 by 1.5		$6x + 12y = 72$	3
Subtract 2 from 3		$9y = 35$	
		$y = 3.889$	
Substitute for y in equation 1		$4x + 8(3.889) = 48$	
		$4x + 31.11 = 48$	
		$4x = 16.888$	
		$x = 4.222$	

Change in value of the objective function

New value:	$C^1 = 50(4.222) + 40(3.889)$	366.66
Original value (C)		360.00
Dual price of constraint 1 = $C^1 - C$ =		6.66

Constraint 2

Increase the value of constraint 2 by 1

Point B is at the intersection of	$4x + 8y = 49$	1
	$6x + 3y = 36$	2
Multiply equation 1 buy 1.5	$6x + 12y = 73.5$	3
Subtract 2 from 3	$9y = 37.5$	
	$y = 4.167$	
Substitute for y in equation 1	$4x + 8(4.167) = 49$	
	$4x + 33.33 = 49$	
	$4x = 14.67$	
	$x = 3.917$	

Change in value of the objective function

New value:	$C^1 = 50(3.917) + 40(4.167)$	362.50
Original value (C)		360.00
Dual price of constraint 2 = $C^1 - C$ =		2.50

1.3 Dual prices and business problems

The dual price of a constraint is always expressed in terms of the units of that constraint. Thus, the dual price of a labour constraint is expressed in terms of an amount of currency per hour.

What the amount actually means depends on the objective function. If the objective function is expressed in terms of profit (or contribution), the dual price per hour will also be expressed in terms of profit (or contribution) per hour.

A common mistake is to say that the dual price is the maximum amount that a business would pay to acquire one extra unit of resource. This is incorrect as the dual price is expressed in terms of profit which already includes the basic cost of that unit. In fact, the dual price is the maximum premium that a business would pay for an extra unit of resource above and beyond the basic price of that unit.

Example: Meaning of dual price

An hour of labour costs ₦100.

The objective function is expressed in terms of contribution.

The dual price of labour is found to be ₦30.

This means that one extra hour of labour increases the contribution by ₦30.

The contribution already includes the cost of labour so this extra ₦30 is after taking the cost of labour into account.

The business would be prepared to pay up to a maximum of ₦30 (₦100 + ₦30) for one extra hour of labour. Beyond this price, contribution would be reduced.

Practice question **1**

This is a continuation of a question from the previous chapter.

Lagos Manufacturing Limited makes and sells two versions of a product called Mark 1 and Mark 2.

The company used linear programming based on the following information to calculate the product mix that would maximise profit and contribution:

	Mark 1	Mark 2
Direct materials per unit	2 kg	4 kg
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

	Resource available
Direct materials	24,000 kg
Direct labour hours	18,000 hours

The optimal solution was found to be at the intersection of the following constraints.

Direct materials	$2x + 4y = 24,000$
Direct labour	$3x + 2y = 18,000$

The contribution resulting from this product mix was obtained as follows:
Solving the above equations showed the optimal product mix to be:

Mark 1 (x)	3,000 units
Mark 2 (y)	4,500 units

The contribution resulting from this product mix was:

$$C = 10x + 15y$$

$$C = 10\ (3,000) + 15\ (4,500) = 97,500$$

Calculate the dual price of direct materials and the dual price of direct labour.

Practice question **2**

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.

Calculate the optimum production plan for the company and the dual prices of resources. (Hint: Remember that non-limiting constraints have a dual price of zero).

1.4 Limit to the dual price

The dual 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 dual price for additional units of the resource will become zero.

1.5 Slack

Slack refers to the amount of a constraint that is not used in the optimal solution to a linear programming problem.

Only non-limiting resources have slack. Limiting resources are fully utilised so never have any slack.

The amount of slack in any non-limiting resources is easily found by substituting the optimum product mix into the equation for that resource. This would show how much of that resource was needed for the optimum solution. This could then be compared to the amount of resource available to give the slack.

2 SIMPLEX

Section overview

- Preliminary information
- Background to simplex method
- Simplex technique: Constructing the initial tableau
- Simplex technique: First transformation
- Simplex technique: Second transformation
- Interpretation of the final tableau
- Summary

2.1 Preliminary information

This section does not explain the simplex method. Instead, it introduces and explains certain ideas which will seem completely unrelated but which you will find useful when you come to try to understand the simplex method.

Matrices

A matrix is a rectangular array of numbers consisting of a number of rows and columns. Matrices are an important tool used in solving all kinds of mathematical problems. Matrices are not in your syllabus so very little will be explained here except what you need to know.

An identity matrix is one where the number of rows is the same as the number of columns and the elements in the leading diagonal are all equal to one with all the other elements being equal to zero. (The leading diagonal is the one that slants down from the top left hand corner to the bottom right hand corner).

The following are examples of identity matrices:

Example: Identity matrices:

Matrix A

$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Matrix B

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Identity matrices have several important uses but what has been mentioned above is all you need to know.

Basic and non-basic variables

Algebra is used to describe relationships between variables and on some occasions to solve for values of those variables.

Consider the following:

It is easy to find the value of x when it is contained in a single equation with no other unknowns. For example x + 40 = 100

It is not so easy to solve for x in an equation where there are two unknowns. For example, x + y =100.

However, we could solve for x if we assign a value to y. In other words, we could say what the value of x would be given a certain value of y.

As a general statement, if there are more variables than the number of equations that contain those variables the number of variables must be reduced to the number of equations by having values assigned to them. The easiest value to assign is zero.

- The variables to which a value (zero) is assigned are called non-basic variables.
- The variables which are calculated after values are assigned to others are called the basic variables.

This might be a little difficult to understand. What it means is that if there are four unknowns (say a, b, c and d) which appear in only three equations, a value must be assigned to one of the variables (say a, b, c or d) as a mechanism to allow the calculation of values for the others. Suppose a was set to be equal to zero.

- b, c and d are called basic variables.
- a is a non-basic variable.

Please do not worry if all of this seems a little mysterious. You probably have never had to do this before and the truth is that you could learn to do simplex without knowing it simply by following a procedure. However, this information will allow you to understand what the starting point of simplex is all about.

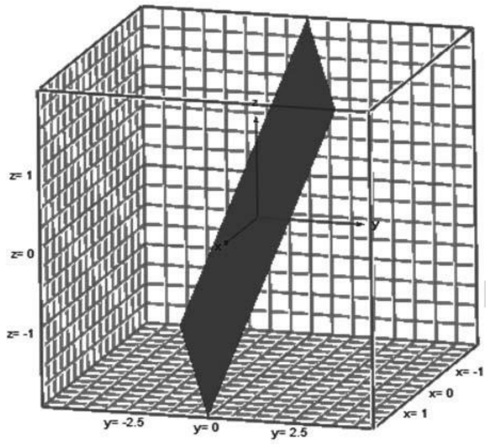
2.2 Background to simplex method

So far (in the previous chapter) linear programmes were solved for problems where there were two unknowns. In cases like this, the problem can be represented graphically as we need a dimension (y axis and x axis) for each unknown so that constraints containing the two unknowns can be drawn as a straight line.

If there are three or more unknowns things become a little trickier to imagine. If there are three variables then the value of each variable would change in two directions in response to changes in the other two variables. In this case, an equation containing the three unknowns would be drawn as a plane (flat service). The following is a simple example of this:

Illustration: 3 dimensional (3d) plot of equation with 3 variables

$$y = x + z$$



It is easy to imagine other equations being drawn in the same way to generate a feasible volume.

When we face problems with 4 or more variables, it becomes impossible to visualise them in a diagrammatic way. A mathematician would not even try, but be happy in the knowledge that he or she can describe the information mathematically.

Simplex is a technique that can be used to solve linear programmes with any number of variables. It is quite tricky to use but it is usually carried out using a computer programme. However, you might be asked to demonstrate an understanding of a simple example.

An example with just two unknowns will be used to illustrate the technique. This is because it becomes progressively more difficult to keep track of what is happening as the number of unknowns increases but the process is just the same for any number of unknowns.

Simplex

Simplex is a tabular solution procedure for solving linear programmes.

Simplex works by establishing an initial table that represents a corner of the feasible region and then moves to the next point. The direction of movement is decided by which of the directions has the biggest impact on the objective function.

- The starting point (called the initial tableau) is constructed to show the situation at the origin of the feasible area/volume where x and y are both zero and the value of the objective function is therefore zero. This is described as the initial feasible solution. It is the starting point for finding the optimum point in the feasible region.
- The table is then transformed to calculate the value of the objective function at the next "corner" of the feasible area/volume.
- This continues until the optimum is found.

This is best explained with an example. We will use an example based on one that you have already seen in the previous chapter.

2.3 Simplex technique: Constructing the initial tableau

Example: Simplex (starting data)

Assume that the following information relates to the profit and constraints of a two product business.

Maximise $Z = 50x + 40y$

Subject to the constraints

$6x + 3y \leq 36$

$4x + 8y \leq 48$

Step 1: Inequalities into equalities

The first thing to do is to change the inequalities into equalities. This is done by introducing a slack variable into each equation. A slack variable represents the amount of unused resource in the equation. Of course, this will turn out to be zero in the final solution if the equation is a limiting constraint.

The constraints become as follows:

Example: Simplex: Inequalities changed to equalities

$$6x + 3y + S1 = 36$$
$$4x + 8y + S2 = 48$$

The equations are said to be in the standard form. This means (in part) that they now equate to a value.

There are 4 variables (x, y, S1 and S2) but only 2 constraints. It is only possible to solve for the same number of variables as there are constraints. A zero value must be assigned to two of the constraints and then values of the others can be calculated.

Zero value is assigned to ***x*** and to ***y*** (they become the non-basic variables). Note that you do not have to do anything here. This is simply explaining what the first table means. In the above equations if ***x*** and ***y*** are both zero, S1 = 36 and S2 = 48. S1 and S2 are now the basic variables. Just remember this for a minute. We will return to it.

The objective function must also be expressed in the standard form. This is easy to do by rearranging the equation.

Example: Simplex: Rearrange the objective function into the standard form

$$Z = 50x + 40y$$

Therefore: $Z – 50x – 40y = 0$

If this business did not face any constraints it would make as many items of ***x*** as possible. This is because each item of ***x*** made provides a higher reward (50) than each item of ***y***(40).

Expressing the objective function in the standard form does not change this. However, it does change the sign associated with the profit of each item. The profit from an item of ***x*** is represented as a value of –50 but this is only because we have rearranged the function. Items of ***x*** are still more profitable than items of ***y***.

Step 2: Assemble the initial tableau

The resultant equations can then be used to construct a table called the initial tableau.

This table consists of three rows, one for each constraint and one for the objective function. (If there were more constraints there would be more rows).

The table consists of a series of columns. The first column is the variable that each equation solves to and the last column is the value that the equation solves to. In between there is a column for each unknown. The heading for these columns is the unknown variable being solved for. The content of each columns is the coefficient of each unknown.

Example: Simplex: Initial tableau

Basic variables	x	y	S1	S2	Quantity
S1	6	3	1	0	36
S2	4	8	0	1	48
Z	–50	–40	0	0	0

It is worth spending some time to ensure that you understand what this initial tableau means.

Each line represents an equation. The first column highlights what is being solved in the equation set out in the remaining columns. For example the first line means:

$$S1 = 6x + 3y + S1 + 0 = 36$$

In other words, the tableau shows the values of the basic constraints (S1 and S2) and of the objective function when both ***x*** and ***y*** are equal to zero. This is at the origin of the ***x*** and ***y*** axes.

- The first line says that ***S***1 (in the left hand column) = 36 (in the right hand column) when ***x*** = zero (therefore 6x = zero) and ***y*** = zero (therefore 3y = zero). The slack variable is 36 being all of the available resource because no products are being made.
- The second line says that ***S2*** (in the left hand column) = 48 (in the right hand column) when ***x*** = zero (therefore 4x = zero) and ***y*** = zero (therefore 8y = zero). The slack variable is 48 being all of the available resource because no products are being made.
- The value of the objective function (***Z***) is zero as nothing is being produced.

Note that the rows and columns for the basic variables (***S1*** and ***S2***) form a 2 by 2 identity matrix.

2.4 Simplex technique: First transformation

The simplex approach involves moving to an adjacent point on the feasible region in order to see the impact on the objective function.

This is done in order of which movement has the biggest positive impact on the objective function. Note that this is shown as the biggest negative value in the ***Z row***.

Moving to an adjacent point involves redrafting the table to represent that point. One of the non-basic variables (i.e. the one with the most negative value on the ***Z row***) becomes basic and replaces an existing basic variable. (The number of rows and columns remains constant.

- The basic variable being replaced is called the exit variable.
- The non-basic variable replacing the original basic variable is called the entry variable.

Example: Simplex: Initial tableau

Basic variables	x	y	S1	S2	Quantity
S1	6	3	1	0	36
S2	4	8	0	1	48
Z	–50	–40	0	0	0

Identifying the entry variable

The largest negative value in the ***Z row*** is –50. This is in the ***x*** column. This column is now called the pivotal column and ***x*** is the entry variable.

Example: Simplex: First transformation – entry variable

Basic variables	x	y	S1	S2	Quantity
S1	6	3	1	0	36
S2	4	8	0	1	48
Z	–50	–40	0	0	0

Identifying the exit variable

The quantity of each constraint in the ***Quantity*** column is divided by the value in that line in the pivotal column.

Every number in the quantity column is divided by each equivalent value from the same line in the pivotal column. If a value is negative the answer is ignored and there is no entry made for it.

The row with the lowest figure resulting from this division is the exit variable. It leaves the solution to be replaced by ***x***. This is the S1 row in the example (see below).

Example: Simplex: First transformation – exit variable

Basic variables	x	y	S1	S2	Quantity	
S1	6	3	1	0	36	$^{36}/_{6} =$ 6
S2	4	8	0	1	48	$^{48}/_{4} =$ 12
Z	–50	–40	0	0	0	

Replacing the exit variable with the entry variable

This is the most difficult part to understand so we will proceed step by step.

The values for entry variable in the pivotal column must be restated to the values that were in the column for the exit variable. They take the exit variable's place as part of the identity matrix. In other words, the ***S1*** column reading from the top was 1, 0 ,0. The values in the ***x*** column must become 1, 0, 0.

However, each row is an equation. If one value in a row changes (as they are due to replacing values in the x column), other figures must be changed in order to keep the equation in balance.

We want to change each equation so that we end up with the table looking as follows:

Example: Simplex: First transformation – to show how the pivotal column should look after the transformation.

Basic variables	x	y	S1	S2	Quantity
x	1	?	?	?	?
S2	0	?	?	?	?
Z	0	?	?	?	?

The value in the pivotal row of the pivotal (x) column must be changed from 6 to 1. This is achieved by dividing the original value by 6. Therefore, the equation in the first row (now the x row) can be maintained if every other number is also divided by 6.

Example: Simplex: First transformation to show how the pivotal row looks after the transformation.

Basic variables	x	y	S1	S2	Quantity
x	1	$^3/_6$	$^1/_6$	0	$^{36}/_6 = 6$
S2	0	?	?	?	?
Z	0	?	?	?	?

The value in the second row of the ***x*** column must be changed from 4 to 0. This is achieved by taking the pivotal row (either before or after the transformation), perhaps adjusting it so that the coefficients of ***x*** match and then adding it to or subtracting it from the second row. This is difficult to understand so we will show you in a number of ways.

Example: Working – Adjusting the second row so that the value in the x column is zero.

Multiply values in the pivotal row before its transformation by –2/3 and add the resultant row to the second row.

Basic variables	x	y	S1	S2	Quantity
x	6	3	1	0	36
Multiply	$\times -^2/_3$	$\times -^2/_3$	$\times -^2/_3$	$\times -^2/_3$	$\times -^2/_3$
=	–4	–2	–2/3	0	–24
S2 before	4	8	0	1	48
S2 after	0	6	$-^2/_3$	1	24

Or it could have been done as follows:

Example: Working – Adjusting the second row so that the value in the x column is zero.

Multiply values in the pivotal row after transformation by –4 and add the resultant row to the second row.

Basic variables	x	y	S1	S2	Quantity
x	1	$^3/_6 = 0.5$	$^1/_6$	0	$^{36}/_6 = 6$
Multiply	×–4	×–4	×–4	×–4	×–4
=	–4	–2	$-^2/_3$	0	–24
S2 before	4	8	0	1	48
S2 after	0	6	$-^2/_3$	1	24

After the second row is transformed the table will look as follows:

Example: Simplex: First transformation after the pivotal row and the second row have been transformed

Basic variables	x	y	S1	S2	Quantity
x	1	$^{3}/_{6}$	$^{1}/_{6}$	0	6
S2	0	6	$-^{2}/_{3}$	1	24
Z	0	?	?	?	?

The same thing must be done for the ***Z row***.

The value in the x column in the ***Z row*** is –50 but this must be changed to zero. This represents the fact that all possible items of ***x*** are being made at this point so it is not possible to make any further contribution.

The value in the ***x*** column in the ***Z row*** is changed to zero by taking the pivotal row (either before or after the transformation), perhaps adjusting it so that the coefficients of ***x*** match and then adding it to or subtracting it from the ***Z row***.

Example: Adjusting the Z row so that the value in the x column is zero.

Multiply values in the pivotal row after transformation by 50 and add the resultant row to the second row.

Basic variables	x	y	S1	S2	Quantity
x	1	$^{3}/_{6}$ = 0.5	$^{1}/_{6}$	0	$^{36}/_{6}$ = 6
Multiply	× 50	× 50	× 50	× 50	× 50
=	50	25	8 $^{1}/_{3}$	0	300
Z before	–50	–40	0	0	0
Z after	0	–15	8 $^{1}/_{3}$	0	300

After the ***Z row*** is transformed the table will look as follows.

Example: Simplex: After the first transformation

Basic variables	x	y	S1	S2	Quantity
x	1	$^{3}/_{6}$	$^{1}/_{6}$	0	6
S2	0	6	$-^{2}/_{3}$	1	24
Z	0	–15	8 $^{1}/_{3}$	0	300

This is how the tableau looks at the end of the first transformation. It has moved to a corner of the feasible area where the largest possible number of ***X*** (6) are being made to give a contribution of 300. (Note that this is 6 units as in the right hand column above, at 50 per unit).

The process continues until there is no negative figure in the ***Z row***. As can be seen above there is a negative figure in the ***Z row***. This means that the objective function can take a higher value so this is not the optimal point.

2.5 Simplex technique: Second transformation

This will be carried out in exactly the same way as before but with less explanation.

Example: Simplex: Second transformation

Tableau brought forward after the first transformation

Basic variables	x	y	S1	S2	Quantity
x	1	$^3/_6$	$^1/_6$	0	6
S2	0	6	$-^2/_3$	1	24
Z	0	–15	$8\ ^1/_3$	0	300

Identify the pivotal column by choosing the column with the most negative figure.

Example: Simplex: Second transformation – Pivotal column

Basic variables	x	y	S1	S2	Quantity
x	1	$^3/_6$	$^1/_6$	0	6
S2	0	6	$-^2/_3$	1	24
Z	0	–15	$8\ ^1/_3$	0	300

The above shows that ***y*** is the entry variable.

Next, identify the pivotal row by dividing each row in the quantity column by the value in the equivalent row in the pivotal column and identifying the lowest figure.

Example: Simplex: Second transformation – Pivotal row

Basic variables	x	y	S1	S2	Quantity	
x	1	$^3/_6$	$^1/_6$	0	6	$6 \div {^3/_6} = 12$
S2	0	6	$-^2/_3$	1	24	$^{24}/_6 = 4$
Z	0	–15	$8\ ^1/_3$	0	300	

The above shows that ***S2*** is the exit variable

Values in the ***y*** column must complete the identity matrix. That is to say they must look as follows:

Example: Simplex: Second transformation – Pivotal row

Basic variables	x	y	S1	S2	Quantity
x	1	0	?	?	?
y	0	1	?	?	?
Z	0	0	?	?	?

The value in the pivotal row of the pivotal (y) column must be changed from 6 to 1. This is achieved by dividing the original value by 6. Therefore, the equation in the pivotal row (now the y row) can be maintained if every other number is also divided by 6.

Example: Simplex: Second transformation – Pivotal row

Basic variables	x	y	S1	S2	Quantity
x	1	0	?	?	?
y	0	1	$-\frac{1}{9}$	$\frac{1}{6}$	4
Z	0	0	?	?	?

The value in the first row of the pivotal column is 0.5 (3/6) but must become zero. This can be achieved by multiplying the pivotal row by – 0.5 and adding the result to the first row.

Example: Working – Adjusting the first row so that the value in the y column is zero.

Multiply values in the pivotal row after transformation by –0.5 and add the resultant row to the second row.

Basic variables	x	y	S1	S2	Quantity
y	0	1	$-\frac{1}{9}$	$\frac{1}{6}$	4
Multiply	×–0.5	×–0.5	×–0.5	×–0.5	×–0.5
=	0	×–0.5	$\frac{1}{18}$	$-\frac{1}{12}$	–2
x before	1	0.5 ($\frac{3}{6}$)	$\frac{1}{6}$	0	6
x after	1	0	$\frac{4}{18} = \frac{2}{9}$	$-\frac{1}{12}$	4

Example: Simplex: Second transformation – x row

Basic variables	x	y	S1	S2	Quantity
x	1	0	$^{2}/_{9}$	$-\,^{1}/_{12}$	4
y	0	1	$-^{1}/_{9}$	$^{1}/_{6}$	4
Z	0	0	?	?	?

The value in the ***Z row*** of the pivotal column is – 15 but must become zero. This can be achieved by multiplying the pivotal row by 15 and adding the result to the ***Z row***.

Example: Working – Adjusting the first row so that the value in the y column is zero.

Multiply values in the pivotal row after transformation by –0.5 and add the resultant row to the second row.

Basic variables	x	y	S1	S2	Quantity
y	0	1	$-^{1}/_{9}$	$^{1}/_{6}$	4
Multiply	× 15	× 15	× 15	× 15	× 15
=	0	15	$-^{15}/_{9}$	$^{15}/_{6}$	60
Z before	0	–15	$^{75}/_{9}$ (8 $^{1}/_{3}$)	0	300
Z after	0	0	$^{60}/_{9}$ = $^{20}/_{3}$ = 6$^{2}/_{3}$	$^{15}/_{6}$ = 2 $^{1}/_{2}$	360

Example: Simplex: Second transformation – Final tableau

Basic variables	x	y	S1	S2	Quantity
x	1	0	$^{2}/_{9}$	$-\,^{1}/_{12}$	4
y	0	1	$-^{1}/_{9}$	$^{1}/_{6}$	4
Z	0	0	6 $^{2}/_{3}$	2 $^{1}/_{2}$	360

There is no negative figure in the **Z row** so this is an optimal solution.

Comment

The above process is complex. You may be forgiven for asking why anyone would use the technique to solve an example like this when it is so much easier using the techniques covered earlier. The answer is that nobody would use this technique to solve this example. The example has been used to explain the process. A more complex example could have been used but would have required further transformations.

Also remember that this is usually carried out using a computer which reduces the effort to formulating the problem and inputting the data and then to interpreting the final tableau.

2.6 Interpretation of the final tableau

Example: Simplex: Final tableau brought forward

Basic variables			S1	S2	Quantity
x					4
y					4
Z	0	0	6 $^2/_3$	2 $^1/_2$	360

Optimum product mix

Dual price of x

Dual price of y

Value of objective function at optimal product mix

2.7 Summary

The example was worked in far more detail than would normally be used to answer a question.

This section shows what a normal answer wold look like (ignoring the initial formulation of the equations).

Example: Step 1: Set up the initial tableau

Basic variables	x	y	S1	S2	Quantity
S1	6	3	1	0	36
S2	4	8	0	1	48
Z	–50	–40	0	0	0

Example: Step 2: Identify entry and exit variables

Basic variables	x	y	S1	S2	Quantity	
S1	6	3	1	0	36	$^{36}/_6 =$ 6
S2	4	8	0	1	48	$^{48}/_4 =$ 12
Z	–50	–40	0	0	0	

Example: Step 3: First transformation

Basic variables	x	y	S1	S2	Quantity
x	1	$^3/_6$	$^1/_6$	0	6
S2	0	6	$-^2/_3$	1	24
Z	0	–15	$8\ ^1/_3$	0	300

There is a negative value in the objective function row so the solution is not optimum.

Example: Step 4: Second transformation

Basic variables	x	y	S1	S2	Quantity
x	1	0	$^2/_9$	$-\ ^1/_{12}$	4
y	0	1	$-^1/_9$	$^1/_6$	4
Z	0	0	$6\ ^2/_3$	$2\ ^1/_2$	360

There is no negative figure in the **Z row** so this is an optimal solution.

Example: Step 5: Interpret the final tableau

Basic variables			S1	S2	Quantity
x					4
y					4
Z	0	0	$6\ ^2/_3$	$2\ ^1/_2$	360

Optimum product mix

Dual price of x

Dual price of y

Value of objective function at optimal product mix

Practice question: Simplex **3**

Maximise:

Z = 5a + 4b + 3c – d

Subject to:

2a	+b	+ c	+2d	≤ 20
a	+ 2b	+ 5c	+ 3d	≤ 15
-a	+b		+2d	≤ 10

3 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Calculate the dual price and explain what it means
- Set up the initial tableau for simplex
- Transform the tableau to a solution
- Interpret the final tableau

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

Dual price of direct materials

	2x + 4y	=	24,001	1
	3x + 2y	=	18,000	2
Multiply (2) by 2:	6x + 4y	=	36,000	3
Subtract (1) from (3):	4x	=	11,999	
Therefore	**x**	**=**	**2,999.75**	
Substitute in equation (1)	2 (2,999.75) + 4y	=	24,001	
	4y	=	18,001.5	
	y	**=**	**4,500.375**	

Contribution = 10x + 15y

Contribution = 10(2,999.75) + 15(4,500.375) =

New contribution	97,503.1
Original contribution	97,500.0
Dual price per	3.1

Dual price of direct labour

	2x + 4y	=	24,000	1
	3x + 2y	=	18,001	2
Multiply (2) by 2:	6x + 4y	=	36,002	3
Subtract (1) from (3):	4x	=	12,002	
Therefore	**x**	**=**	**3,000.5**	
Substitute in equation (1)	2 (3,000.5) + 4y	=	24,000	
	4y	=	17,999	
	y	**=**	**4,499.75**	

Contribution = 10x + 15y

Contribution = 10(3,000.5) + 15(4,499.75) =

New contribution	97,503.8
Original contribution	97,500.0
Dual price per	3.8

Solution **2**

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

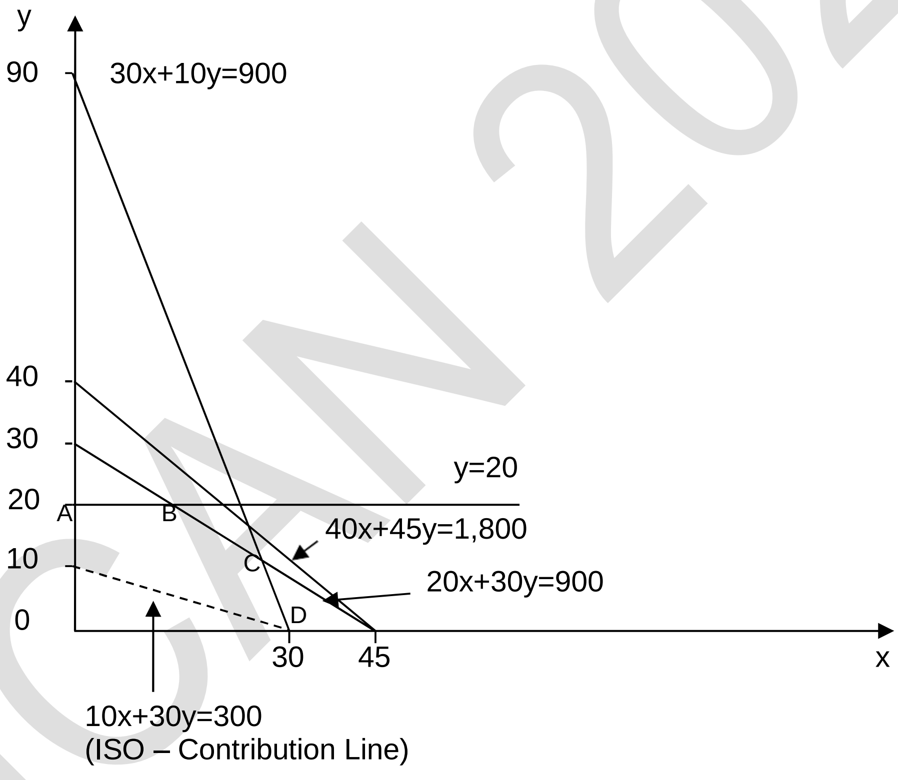
Let y = the number of units of Product C per day

The objective function is to maximise the total contribution given by C = 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 × ₦10) + (20 × ₦30) = ₦750 per day.

Solution (continued) **2**

Dual price of skilled labour

	y	=	20	1
	20x + 30y	=	901	2
Multiply (1) by 30	30y	=	600	3
Subtract (3) from (2):	20x	=	301	
Therefore	**x**	**=**	**15.05**	

x does not appear in the other limiting constraint. This remains as y = 20.

Contribution = 10x + 30y

Contribution = 10(15.05) + 30(20) = 750.5

New contribution	750.5
Original contribution	750.0
Dual price per	0.5

The dual price of skilled labour is therefore ₦0.50 per minute, or ₦30 per hour.

Dual price of sales demand

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

x does not appear in the other limiting constraint. This remains as y = 21.

Contribution = 10x + 30y

Contribution = 10(13.5) + 30(21) = 765

New contribution	765.5
Original contribution	750.0
Dual price per	15.0

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

Dual price of non-limiting constraints

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 dual price for both types of machine is zero.

Solution **3**

Initial tableau

Basic variables	a	b	c	d	S1	S2	S3	Quantity
S1	2	1	1	2	1	0	0	20
S2	1	2	5	3	0	1	0	15
S3	-1	1	0	2	0	0	1	10
Z	-5	-4	-3	1	0	0	0	0

Pivotal column and row

Basic variables	a	b	c	d	S1	S2	S3	Quantity
S1	2	1	1	2	1	0	0	20
S2	1	2	5	3	0	1	0	15
S3	-1	1	0	2	0	0	1	10
Z	-5	-4	-3	1	0	0	0	0

First transformation

Basic variables	a	b	c	d	S1	S2	S3	Quantity
a	1	0.5	0.5	1	0.5	0	0	10
S2	0	1.5	4.5	2	-0.5	1	0	5
S3	0	1.5	0.5	3	0.5	0	1	20
Z	0	-1.5	-0.5	6	2.5	0	0	50

There are negative values in the Z row so this is not the optimal solution.

Pivotal column and row

Basic variables	a	b	c	d	S1	S2	S3	Quantity
a	1	0.5	0.5	1	0.5	0	0	10
S2	0	1.5	4.5	2	-0.5	1	0	5
S3	0	1.5	0.5	3	0.5	0	1	20
Z	0	-1.5	-0.5	6	2.5	0	0	50

Second transformation

Basic variables	a	b	c	d	S1	S2	S3	Quantity
a	1	0	-1	0.33	0.67	-0.33	0	8.33
b	0	1	3	1.33	-0.33	0.67	0	3.33
S3	0	0	-4	1	1	-1	1	15
Z	0	0	4	8	2	1	0	55

There are no negative values in the Z row so this is the optimal solution.

Skills level
Performance management

CHAPTER 18

Other decisions

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	Decision making		
	1	**Advanced decision-making and decision-support**	
		c	Apply relevant cost concept to short term management decisions including make or buy, outsourcing, shut down, one-off contracts, adding a new product line, sell or process further, product and segment profitability analysis, etc.

Exam context

This chapter explains the application of relevant costing in further decision making techniques.

By the end of this chapter, you should be able to:

- Analyse relevant costs to decide whether to make or buy a good
- Analyse relevant costs to price contracts
- Analyse relevant costs to make shutdown decisions
- Analyse relevant costs to make further processing decisions

1 MAKE-OR-BUY DECISIONS:

Section overview

- Introduction
- Make-or-buy (outsource) decisions
- Make-or-buy decisions with scarce resources
- Non-financial considerations

1.1 Introduction

Relevant costs can be applied to both short-term and long-term decisions.

- Short-term decisions are decisions where the financial consequences occur soon after the decision is taken. For example, a short-term decision may result in an immediate increase in profit (additional net cash inflows), or an increase in annual profits and cash flows.
- A long-term decision is one where a capital investment may be required and the benefits of the investment will be obtained over a period of several years.

The concept of relevant costs is the same for both short-term and long-term decisions, except that for long-term decisions the time value of money should also be taken into consideration.

Examples of management decisions where relevant costing is used are:

- One-off contract decisions: management might want to decide whether or not to undertake a contract for a specified fixed price. If it is a one-off contract, rather than regular production work, it would be worthwhile undertaking the contract if the extra revenue from the contract is higher than the relevant costs of doing the work (including any opportunity costs).
- Make-or-buy decisions
- Shutdown decisions
- Joint product further processing decisions.

1.2 Make-or-buy (outsource) decisions

A make-or-buy decision is a decision about:

- whether to make an item internally or to buy it from an external supplier, or
- whether to do some work with internal resources, or to contract it out to another organisation such as a sub-contractor or an outsourcing organisation.

The economic basis for the decision whether to make internally or whether to buy externally (outsource production) should be based on relevant costs. The preferred option **from a financial viewpoint** should be the one that has the lower relevant costs.

A financial assessment of a make-or-buy decision typically involves a comparison of:

- the costs that would be saved if the work is outsourced or sub-contracted, and
- the incremental costs that would be incurred by outsourcing the work.

Example: Make-or-buy decisions

A company manufactures a component that is included in a final product that it also manufactures. Management have identified an external supplier who would be willing to supply the component.

The variable cost of manufacturing the component internally is ₦100 and the external supplier would be prepared to supply the components for ₦130 each.

It has been estimated that cash savings on general overhead expenditure will be ₦48,000 each year if internal production is ended.

The company needs 1,000 units of the component each year.

Required

Should the company make or buy the component?

Answer

The annual relevant costs and benefits of a decision to buy the components externally can be presented as follows:

	₦
Extra costs of purchasing externally (1,000 units × (₦130 - ₦100))	(30,000)
Cash savings in overhead expenditures	48,000
Net benefit from external purchasing (outsourcing) per year	18,000

Conclusion: The company would increase its profit by purchasing externally instead of making the items in-house. The recommendation on financial considerations is therefore to buy (outsource production), not make internally.

1.3 Make-or-buy decisions with scarce resources

A different situation arises when an entity is operating at full capacity, and has the opportunity to outsource some production in order to overcome the restrictions on its output and sales. For example a company might have a restriction, at least in the short-term, on machine capacity or on the availability of skilled labour. It can seek to overcome this problem by outsourcing some work to an external supplier who makes similar products and which has some spare machine time or labour capacity.

In this type of situation, a relevant costing approach is to assume that the entity will:

- seek to maximise its profits, and therefore
- outsource some of the work, provided that profits will be increased as a consequence.

The decision is about which items to outsource, and which to retain in-house. The profit-maximising decision is to outsource those items where the costs of outsourcing will be the least.

To identify the least-cost outsourcing arrangement, it is necessary to compare:

- the additional costs of outsourcing production of an item with
- the amount of the scarce resource that would be needed to make the item in-house.

Costs are minimised (and so profits are maximised) by outsourcing those items where the extra cost of outsourcing is the lowest per unit of scarce resource 'saved'.

The examples below illustrate the relevant costing technique required.

Example: Make-or-buy decisions with scarce resources

A contract cleaning company provides three services; daily office cleaning, intensive cleaning of office space and minor repairs. However it has insufficient resources to do all the work available, and wishes to use a sub-contractor to take on some of the work.

Information relating to the different type of work is as follows:

	Average labour hours per job	Budgeted number of jobs	Variable cost per job(₦)	Sub-contractor quote per job (₦)
Daily office cleaning	4	1,500	600	800
Intensive cleaning	6	400	1,080	1,500
Minor repairs	3	640	560	1,000

There are 8,000 labour hours available.

The services that are to be sub-contracted and the total monthly variable cost are found as follows:

Example (continued): Make-or-buy decisions with scarce resources

The company can do all three types of job more cheaply with its own staff than by hiring the sub-contractor. However provided that it earns more than ₦800 for a daily office cleaning job, ₦1,500 for an intensive cleaning job and ₦1,000 for a minor repairs job, it is profitable to use the sub-contractor to make up the shortfall in in-house resources.

The problem is to decide which work to outsource/sub-contract. The ranking should be established as follows:

	Daily office cleaning	Intensive cleaning	Minor repairs
	₦	₦	₦
Cost of doing the work in-house	600	1,080	560
Cost of sub-contractor	800	1,500	1,000
Extra cost per job (of outsourcing)	200	420	440
Hours saved by sub-contracting (÷)	4	6	3
Extra cost per hour saved	₦50	₦70	₦140
Priority for outsourcing	1st	2nd	3rd
Priority for doing work with own resources	3rd	2nd	1st

Optimum plan

	Total labour hours	Budgeted jobs	Total variable cost (₦)
			₦
Minor repairs	1,920	640	358,400
Intensive cleaning	2,400	400	432,000
Office cleaning (balance)	3,680	920	552,000
Maximum labour hours available	8,000		1,342,400
Sub-contract:			
Office cleaning		580	464,000
			1,806,400

Note: The number of office cleaning jobs outsourced is the total number (1,500) less those performed by own staff (920).

Practice question **1**

A company makes four products, W, X, Y and Z. All four products are made on the same machines, and the machine capacity for the year at the company's factory is 3,500 hours.

The company is able to obtain any of these products in unlimited quantities from a sub-contractor.

Budgeted data is as follows:

Product	**W**	**X**	**Y**	**Z**
Annual sales demand (units)	4,000	6,000	3,000	5,000
	₦	₦	₦	₦
Sales price per unit	150	200	180	170
Variable cost per unit, in-house manufacture	50	70	60	70
Cost of external purchase (outsourcing)	80	118	105	110
Machine hours per unit, in-house production	0.25	0.5	0.3	0.4

Which items should be produced in-house and which should be outsourced? Calculate the total cost associated with the optimal plan.

1.4 Non-financial considerations

When relevant costs are used to make a decision, it is assumed that the decision should be based on financial considerations and whether the decision will add to profit (cash flows).

In reality, however, managers are likely to think about non-financial issues as well as financial issues when making their decisions. The non-financial considerations in any decision will depend on the circumstances, and will vary from one decision to another. Non-financial considerations can influence a decision. In your examination, be prepared to identify relevant non-financial issues in a particular situation, and discuss their potential implications.

Non-financial considerations that will often be relevant to a make-or-buy decision include the following:

- When work is outsourced, the entity loses some control over the work. It will rely on the external supplier to produce and supply the outsourced items. There may be some risk that the external supplier will:
  - produce the outsourced items to a lower standard of quality, or
  - fail to meet delivery dates on schedule, so that production of the end-product may be held up by a lack of components.
- The entity will also lose some flexibility. If it needs to increase or reduce supply of the outsourced item at short notice, it may be unable to do so because of the terms of the agreement with the external supplier. For example, the terms of the agreement may provide for the supply of a fixed quantity of the outsourced item each month.
- A decision to outsource work may have implications for employment within the entity, and it may be necessary to make some employees redundant. This will have cost implications, and could also adversely affect relations between management and other employees.
- It might be appropriate to think about the longer-term consequences of a decision to outsource work. What might happen if the entity changes its mind at some time in the future and decides either (a) to bring the work back in-house or (b) to give the work to a different external supplier? The problem might be that taking the work from the initial external provider and placing it somewhere else might not be easy in practice, since the external supplier might not be co-operative in helping with the removal of its work.

The non-financial factors listed above are all reasons against outsourcing work. There might also be non-financial **benefits** from outsourcing work to an external supplier.

- If the work that is outsourced is not specialised, or is outside the entity's main area of expertise, outsourcing work will enable management to focus their efforts on those aspects of operations that the entity does best. For example, it could be argued that activities such as the management of an entity's fleet of delivery vehicles, or the monthly payroll work, should be outsourced because the entity itself has no special expertise on these areas.
- The external supplier, on the other hand, may have specialist expertise which enables it to provide the outsourced products or services more efficiently and effectively. For example a company might outsource all its IT support operations, because it cannot recruit and retain IT specialists. An external service provider, on the other hand, will employ IT specialists.

2 OTHER SHORT TERM DECISIONS

Section overview

- Applications of relevant costing
- One-off contract decisions
- Shutdown decisions
- Joint product further processing decisions

2.1 Applications of relevant costing

The principles of relevant costing were explained in the previous chapter.

These principles can be applied to any type of management decision, not just make-or-buy decisions. Examples of other types of management decision where relevant costing may be used are:

- One-off contract decisions
- Shutdown decisions
- Joint product further processing decisions.

2.2 One-off contract decisions

Management might have an opportunity to carry out a contract or job for a customer, where the job is 'once only' and will not be repeated in the future. The decision is therefore to decide whether to agree to do the job at the price offered by the customer, or to decide a selling price at which an incremental profit would be made.

If it is a one-off contract, rather than regular production work, it would be worthwhile undertaking the contract if the extra revenue from the contract is higher than the relevant costs of doing the work (including any opportunity costs).

The incremental profit from the one-off contract is the revenue that would be obtained minus the relevant costs.

One-off contract decisions might occur when a company has spare capacity, and an opportunity arises to earn some extra profit. This type of analysis should not be applied to most contract decisions, however, because a company must earn sufficient profits in total to cover its fixed costs and make a profit. Relevant costs do not help management to decide what the size of the profit margin should be, in order to ensure that the company makes an overall profit from all its activities.

Practice question **2**

Contractor Nigeria Limited is deciding whether or not to proceed with a one-off special contract for which it would receive a once-off payment of
₦200,000

Details of relevant costs are:

(a) The special contract requires 200 hours of labour at ₦600 per hour. Employees possessing the necessary skills are already employed by Contractor Nigeria Limited but are currently idle due to a recent downturn in business.

(b) Materials X and Y will be used. 100 tonnes of material X will be needed and sufficient material is in inventory as the material is in common use by the company. Original cost of material in inventory was ₦150 per tonne but it would cost ₦180 per tonne to replace f used in this contract. Material Y is in inventory as a result of previous over-purchasing. The original cost of material Y was ₦50,000 but it has no other use. Unfortunately material B is toxic and if not used in this contract Contractor Nigeria Limited must pay ₦24,000 to have it disposed.

(c) The contract will require the use of a storage unit for three months. Contractor is committed to rent the unit for one year at a rental of ₦8,000 per month. The unit is not in use at present. However, a neighbouring business has recently approached Contractor Nigeria Limited offering to rent the unit from them for ₦11,000 per month.

(d) Overheads are absorbed at ₦750 per labour hour which consists of ₦500 for fixed overhead and ₦250 for variable overhead. Total fixed overheads are not expected to increase as a result of the contract.

A trainee accountant has performed the following calculation which shows that the contract will cost ₦359,000 to deliver and concluded that the contract should therefore not be accepted for ₦200,000.

Description	Relevant cost
	₦
Labour: 200 hours x ₦600	120,000
Material X: 100 tonnes x ₦150	15,000
Material Y: Original cost	50,000
Storage: 3 months x ₦8,000	24,000
Overheads: ₦750 x 200	150,000
Total	359,000

Calculate the relevant cost of the contract and advise whether the contract should be accepted or not on financial grounds.

2.3 Shutdown decisions

A shutdown decision is a decision about whether or not to shut down a part of the operations of a company. From a financial viewpoint, an operation should be shut down if the benefits of shutdown exceed the relevant costs.

A shutdown decision may be a long-term decision when there are large initial expenditures involved (for example, costs of making the work force redundant). For the purpose of the examination, however, any shutdown decision will be a short-term decision.

Example: Shutdown decisions

Afor Ukwu Nigeria Limited makes four products, P, Q, R and S. The budget for next year is as follows:

	P	Q	R	S	Total
	₦000	₦000	₦000	₦000	₦000
Direct materials	300	500	400	700	1,900
Direct labour	400	800	600	400	2,200
Variable overheads	100	200	100	100	500
	800	1,500	1,100	1,200	4,600
Sales	1,800	1,650	2,200	1,550	7,200
Contribution	1,000	150	1,100	350	2,600
Directly attributable fixed costs	(400)	(250)	(300)	(300)	(1,250)
Share of general fixed costs	(200)	(200)	(300)	(400)	(1,100)
Profit/(loss)	400	(300)	500	(350)	250

'Directly attributable fixed costs' are cash expenditures that are directly attributable to each individual product. These costs would be saved if operations to make and sell the product were shut down.

Required

State with reasons whether any of the products should be withdrawn from the market.

Answer

From a financial viewpoint, a product should be withdrawn from the market if the savings from closure exceed the benefits of continuing to make and sell the product. If a product is withdrawn from the market, the company will lose the contribution, but will save the directly attributable fixed costs.

Effect of shutdown	**P**	**Q**	**R**	**S**
	₦	**₦**	**₦**	**₦**
	'000	'000	'000	'000
Contribution forgone	(1,000)	(150)	(1,100)	(350)
Directly attributable fixed costs Saved	400	250	300	300
Increase/(reduction) in annual cash flows	(600)	100	(800)	(50)

Product S makes a loss of ₦350,000 after allocation of general fixed overhead. However, this is misleading as the allocation of general fixed overhead is not a relevant cost. Stopping making product S would reduce annual cash flows because the contribution lost would be greater than the savings in directly attributable fixed costs.

However, withdrawal of product Q from the market would improve annual cash flows by ₦100,000, and withdrawal is therefore recommended on the basis of this financial analysis.

Decision recommended: Stop making and selling product Q but carry on making and selling product S.

2.4 Joint product further processing decisions

Joint products are products manufactured from a common process. In some instances, a company might have a choice between:

- selling the joint product as soon as it is output from the common process, or
- processing the joint product further before selling it (at a higher price).

This is a short-term decision, and the financial assessment should be made using relevant costs and revenues. The financial assessment should compare:

- the revenue that will be obtained (less any selling costs) from selling the joint product as soon as it is output from the common process, and
- the revenue that will be obtained if the joint product is processed further, less the incremental costs of further processing and then selling the product.

Applying relevant costing, the costs of the common process are irrelevant to the decision, because these costs will be incurred anyway, whatever the decision. The decision should be to further process the joint product if the extra revenue from further processing exceeds the extra (relevant) costs of the further processing.

Example: Joint product further processing decisions

A company produces two joint products from a common process. The costs of the common process are ₦4,000 per 100 kilograms of input.

For every 100 kilograms of input to the common process, output consists of 40 kilograms of J1 and 60 kilograms of J2.

J1 can be sold for ₦100 per kilogram and J2 can be sold for ₦160 per kilogram.

Alternatively, J1 can be processed to make a finished product, F1.

Costs of further processing consist of variable costs of ₦60 per kilogram and fixed costs of ₦1,200,000 per year.

Of these fixed costs, ₦960,000 would be directly attributable to the further processing operations, and the remaining ₦240,000 would be an apportionment of general fixed overhead costs.

The further processed product (F1) would have a selling price of ₦280 per kilogram.

It is estimated that 15,000 kilograms of J1 will be produced each year. There are no losses in any process.

The decision as to whether J1 be sold as soon as it is produced from the common process, or further processed into Product F1 is made as follows:

Example (continued) : Joint product further processing decisions

The common processing costs are irrelevant to the further processing decision. The annual relevant costs and benefits of further processing JP1 are as follows:

	₦
Revenue from selling FP1 (per kilogram)	280
Variable further processing cost	(60)
Additional variable revenue from further processing	220
Opportunity cost: sales of JP1 forgone	(100)
Benefit per kilogram from further processing	120
Number of kilograms produced each year	× 15,000
Total annual benefits before directly attributable fixed costs	₦1,800,000
Directly attributable fixed costs of further processing	₦(960,000)
Net annual benefits of further processing	₦840,000

Recommendation: J1 should be processed to make F1, because this will increase annual profit by ₦840,000.

3 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Analyse relevant costs to decide whether to make or buy a good
- Analyse relevant costs to price contracts
- Analyse relevant costs to make shutdown decisions
- Analyse relevant costs to make further processing decisions

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

The selling price for each product is higher than the variable cost of purchasing each product externally; therefore profit will be maximised by making the products in-house or purchasing them externally, up to the full amount of the annual sales demand.

Product	**W**	**X**	**Y**	**Z**
	₦	₦	₦	₦
Variable cost per unit, in-house manufacture	50	70	60	70
Cost of external purchase (outsourcing)	80	118	105	110
Extra cost of outsourcing, per unit	30	48	45	40
Machine hours per unit, in-house production (÷)	0.25	0.5	0.3	0.4
Extra cost of outsourcing, per machine hour saved	₦120	₦96	₦150	₦100
Priority for outsourcing	3rd	1st	4th	2nd
Priority for in-house production	2nd	4th	1st	3rd

The cost-minimising and profit-maximising budget is as follows:

Product	**Machine hours**	**Units**	**Total variable cost**
In-house:			₦
Y	900	3,000	180,000
W	1,000	4,000	200,000
Z (balance)	1,600	4,000	280,000
	3,500		
Outsourced			
Z		1,000	110,000
X		6,000	708,000
Total variable cost			1,478,000

Solutions 2

(a) The relevant cost of labour is zero as no extra cost will be incurred as a result of this contract.

(b) The relevant cost of a material that is used regularly is its replacement cost. Additional inventory of the material must be purchased for use in this contract. The relevant cost of material X is therefore ₦180 per tonne i.e. ₦180 x 100 = ₦18,000

There is a relevant saving from using material Y from not having to pay the disposal cost of ₦24,000.

(c) As Contractor is already committed to rent the storage unit for one year the monthly rental cost is not relevant to the contract. However, the opportunity cost is the foregone rental income that Contractor would have made from the neighbouring business for the three months needed for this contract. i.e. 3 x ₦11,000 = ₦33,000

(d) The fixed overhead is not relevant because there is no increment to fixed overheads expected as a result of this contract. Therefore the relevant overhead cost is just the variable part of ₦250 per hour x 200 hours = ₦50,000

So in total the total relevant cost is ₦82,000 as follows:

Description	Relevant cost
	₦
Labour	0
Material X	18,000
Material Y	(24,000)
Storage	33,000
Overheads	50,000
Total	77,000

Conclusion: The contract should be accepted as it would make an incremental profit to Contractor of ₦123,000 (revenue of ₦200,000 less relevant costs of ₦77,000).

Skills level
Performance management

CHAPTER 19

Pricing

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**			
	1	**Advanced decision-making and decision-support**		
		e	Explain different pricing strategies, including:	
			i	Cost-plus;
			ii	Skimming;
			iii	Market penetration;
			iv	Complementary product;
			v	Product-line;
			vi	Volume discounting; and
			vii	Market discrimination.
		f	Calculate and present numerically and graphically the optimum selling price for a product or service using given data and information by applying relevant cost and economic models and advise management.	

Exam context

This chapter explains different approaches that may be used to set prices.

By the end of this chapter, you should be able to:

- Explain the factors that influence selling prices
- Explain and calculate price elasticity
- Derive cost and demand functions
- Calculate the price (and therefore quantity) that leads to profit maximisation
- Explain different types of pricing strategy

1 FACTORS THAT INFLUENCE PRICE

Section overview

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

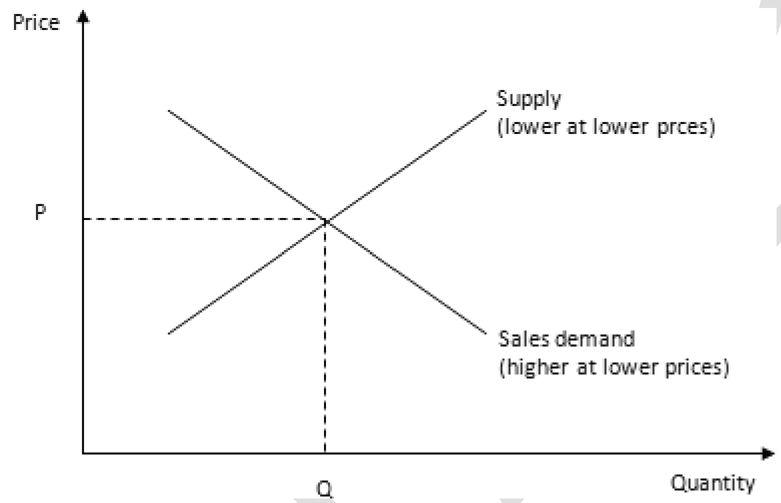
According to basic microeconomic analysis, the sales price for a product in a market is determined by demand and supply.

- 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.

Example: Supply and demand



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 is explained in more detail in a later 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 its 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.

2 PRICE ELASTICITY OF DEMAND

Section overview

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

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 follows:

Formula: Price elasticity of demand

$$= \frac{\text{The change in quantity demanded as a percentage of original demand}}{\text{The change in sales price as a percentage of the original price}} \times 100$$

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: Price elasticity

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

An increase in the price from ₦90 to ₦100 will result in a fall in daily demand from 2,000 to 1,600 units

The price elasticity of demand for product X at a price of ₦90 is calculated as follows:

If the price is increased from ₦90 to ₦100

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

= ₦10/₦90 = + 0.111 or + 11.1%.

PED = - 0.20/ + 0.111 = - 1.8.

Practice questions **1**

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

A fall in the price from ₦50 to ₦40 will result in a rise in daily demand from 8,000 to 9,000 units.

Calculate the price elasticity of demand for product X at a price of ₦50

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.

3 DEMAND EQUATIONS, COST FUNCTIONS AND MAXIMISING PROFIT

Section overview

- Introduction
- Demand curves in imperfect competition
- Profit-maximisation
- Problems using a demand equation
- Incremental revenue and incremental cost

3.1 Introduction

Many scenarios faced by businesses can be mathematically modelled in order to aid decision making. One such area is price setting.

Decisions are made to achieve objectives. The pricing model assumes that the objective of a business is to maximise its profits.

Definitions

Revenue: The income generated from sale of goods or services. It is the price of a good multiplied by the quantity sold.

Marginal revenue: The change in total revenue as a result of selling one extra item. This is the slope of the revenue curve.

Marginal cost: The change in total cost as a result of making one extra item. This is the slope of the cost curve.

A business should continue to make and sell more units as long as the marginal revenue from selling an item exceeds its marginal cost as this will increase profit. Any unit sold once marginal cost exceeds marginal revenue would reduce profit.

The values of marginal cost and marginal revenue depend on the shape of the total cost and total revenue curves of a business.

Revenue curves

There are two sets of market conditions to consider:

- a market in which there is perfect competition; and
- a market in which there is imperfect competition.

Perfect competition requires the existence of many different suppliers competing to sell identical products to many different customers and that all market participants have perfect information to help them to make selling and buying decisions. No single supplier can influence the price of goods as this is determined by the market.

A supplier should make and sell more goods as long as the marginal cost of making them is less than the marginal revenue from selling them (this being equal to the price set by the market.

Perfect competition is rare in practice and not very interesting from a mathematical modelling view. Questions are far more likely to be about a company facing imperfect competition.

3.2 Demand curves in imperfect competition

Suppliers seek to differentiate their products from those of their competitors. This leads to imperfect competition. When imperfect competition exists a supplier can set his own price. However, this has an effect on demand. The degree of this impact depends on the shape of the demand curve faced by a supplier.

A demand curve is a graph showing the quantity demanded at different sales prices. Usually an increase in price leads to a fall in demand. If the link between price and quantity is assumed to be a straight line relationship it can be represented as follows.

Formula: Demand curve

$P = a – bQ$

Where:

P = sales price

Q = quantity demanded

a = sales price when the quantity demanded is 0

b = change in sale price/ change in quantity sold

Example: Deriving a demand curve.

The sales demand curve for a product is straight-line.

Demand = 80,000 units when the sales price is ₦0.

Demand = 0 units when the sales price is ₦40.

Derive the demand curve

a = ₦40 (given)

b =₦40/80,000 = 0.0005

Demand curve: $P = 40 – 0.0005Q$

This means that if a company increases the selling price then the number of goods sold will fall and vice versa.

Revenue = Price × Quantity

The impact of a price change on the total revenue of a company depends on the interaction between the change in price and the change in quantity. In other words it depends on the slope of the revenue curve. This is the marginal revenue (MR).

Calculating MR

Example: Revenue and marginal revenue.

Demand curve: P = 40 – 0.0005Q

Construct the equation for total revenue and then differentiate it with respect to Q to give an expression for marginal revenue.

Demand curve	$P = 40 - 0.0005Q$
Revenue curve:	
Multiply the demand curve by Q	$P \times Q = 40Q - 0.0005Q^2$
	$R = 40Q - 0.0005Q^2$
MR curve by differentiation	$\frac{dR}{dQ} = 40 - 0.001Q$

Calculating MC

Marginal cost is the slope of the total cost curve. An equation for total costs can be constructed (the total cost function) and this can be differentiated with respect to the quantity to find the marginal cost.

Example: Total cost and marginal cost.

A business manufactures goods at a variable cost of ₦2 per unit.

Fixed costs are ₦500,000.

Construct the equation for total costs and then differentiate it with respect to Q to give an expression for marginal costs.

Total costs (TC) = Total fixed costs + Total variable costs

Total variable costs = Variable cost per unit (₦2) × Number of units made (Q)

Total costs given by:	$TC = 500,000 + 2Q$
MC curve by differentiation	$\frac{dTC}{dQ} = 2$

3.3 Profit-maximisation

A company seeks to maximise its profits. Questions ask for the calculation of the quantity that must be sold to maximise profit (from which a selling price can be calculated).

There are two approaches to measuring the quantity that a business needs to sell to maximise profit using either:

- MR = MC; or
- the profit function

MR = MC

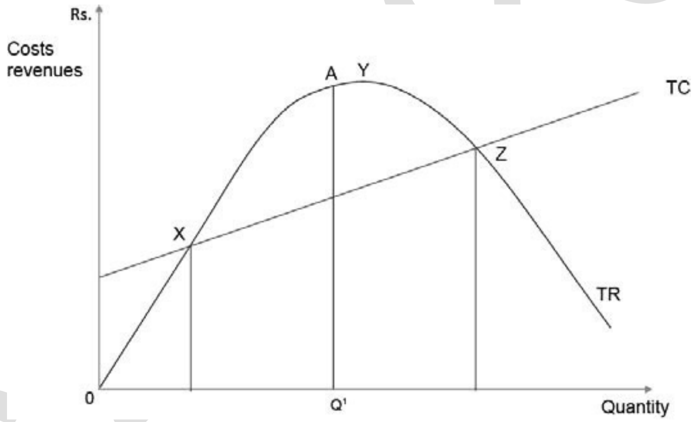
A business should sell an extra unit as long as the marginal revenue (MR) of the sale is greater than its marginal cost (MC).

A company can only sell more and more units by dropping its selling price. Eventually the MR of a sale will become less than its MC.

This implies there is a point where MR = MC at which profit is maximised.

The following diagram shows plots of the revenue curve and cost curve of a product.

Illustration: Profit and cost curves



The business does not start to make profit until the revenue line crosses the total cost line at point X.

Profit is maximised at Q^1. This is where the slope of the revenue curve (MR) equals the slope of the cost curve.

MR = MC approach to finding the selling price and sales quantity at which profit is maximised.

- **Step 1:** Derive the demand curve.
- **Step 2:** Derive the revenue curve by multiplying the demand curve by Q.
- **Step 3:** Derive an expression for MR by differentiating the revenue curve.
- **Step 4:** Set MR = MC and solve for the sales quantity that maximises profit.
- **Step 5:** Calculate the price at which profits are maximised by substituting the value of Q found at step 4 into the demand curve.

The marginal cost is found by differentiating the total cost line. Usually we assume that the cost function is straight line so marginal cost is simply the slope of this line.

Example

Demand curve: P = 40 – 0.0005Q

Total cost line: Total cost = 500,000 + 2Q

Step 1: Demand curve	P = 40 – 0.0005Q
Step 2: Revenue curve: Multiply the demand curve by Q	$R = 40Q - 0.0005Q^2$
Step 3: MR curve by differentiation	$\frac{dR}{dQ} = 40 - 0.001Q$
Step 4: (Set MR = MC) Note that the marginal cost is the slope of the cost line	40 – 0.001Q = 2 40 – 2 = 0.001Q Q = 38,000
Step 5: Price by substitution for Q into the demand function.	P = 40 – 0.0005Q P = 40 – 0.0005(38,000) P = 21

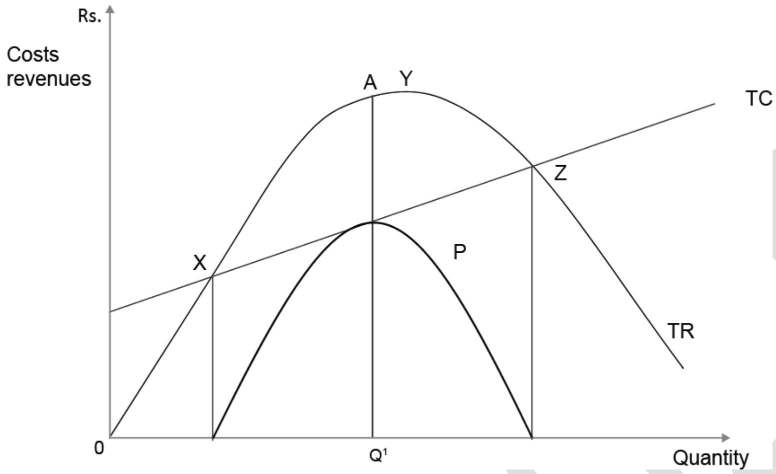
Conclusion:

Profit is maximised by selling 38,000 units for ₦21 per unit.

Using the profit function

The following illustration shows the curves of the revenue function, total cost function and the profit function.

Illustration: Profit and cost curves



The business does not start to make profit until the revenue line crosses the total cost line at point X.

Profit is maximised at Q^1. This is where the slope of the revenue curve (MR) equals the slope of the cost curve. Notice that the point A is not the highest point on the revenue curve. Q^1 is the quantity that maximises profit not the quantity that maximises revenue.

As the revenue line passes point A revenue continues to increase until point Y but profit falls because the marginal cost is greater than marginal revenue.

After the point Y the revenue curve slopes downwards as total revenue falls.

At point Z the revenue line passes below the total cost line. The company would make a loss from this point.

Profit function approach to finding the selling price and sales quantity at which profit is maximised.

- **Step 1:** Derive the demand curve.
- **Step 2:** Derive the revenue curve by multiplying the demand curve by Q.
- **Step 3:** Derive the total cost curve.
- **Step 4:** Derive the profit curve (Profit = Revenue less total costs).
- **Step 5:** Differentiate the profit curve to find its slope
- **Step 6:** Set the differential coefficient to zero and solve for Q. This is the profit maximising quantity. (You can prove that this is a maximum by checking that the second differential is negative).
- **Step 7:** Calculate the price at which profits are maximised by substituting the value of Q found at step 6 into the demand curve.

Example

Demand curve: $P = 40 - 0.0005Q$

A business manufactures goods at a variable cost of ₦2 per unit.

Fixed costs are ₦500,000.

Step 1: Demand curve	$P = 40 - 0.0005Q$
Step 2: Revenue curve:	
Multiply the demand curve by Q	$R = 40Q - 0.0005Q^2$
Step 3: Derive the total cost curve	$TC = 500,000 + 2Q$
Step 4: Derive the profit curve	$P = R - C$
	$P = 40Q - 0.0005Q^2 - (500,000 + 2Q)$
	$P = 40Q - 0.0005Q^2 - 500,000 - 2Q$
	$P = 38Q - 0.0005Q^2 - 500,000$
Step 5: Differentiate the profit curve to find its slope	$\frac{dP}{dQ} = 38 - 0.001Q$
Step 6: Set the differential coefficient to zero and solve for Q	$0 = 38 - 0.001Q$
	$0.001Q = 38$
	$Q = 38,000$
Step 7: Price by substitution for Q into the demand function.	$P = 40 - 0.0005Q$
	$P = 40 - 0.0005(38,000)$
	$P = 21$

Conclusion:

Profit is maximised by selling 38,000 units for ₦21 per unit.

Practice question **2**

Calculate the profit maximising quantity and price in each of the following scenarios.

1 At a price of ₦12 per unit, the expected annual sales demand is 300,000 units

Annual sales demand falls or increases by 2,000 units for every ₦0.50 increase or reduction in price.

Marginal cost is ₦2.

2 A major hotel is planning a gala dinner, at which there will be up to 800 places available.

The initial idea was to charge ₦1,000 per person and at this price the hotel would expect to sell 600 tickets.

Market research suggests that for every ₦50 increase or reduction in the ticket price, demand will fall or increase by 20.

The variable cost per person for the dinner will be ₦250.

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.

- There 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: Incremental approach

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.

Example (continued): Incremental approach

	₦
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: 6,000 units × ₦3	18,000
Overtime premium for 2,000 units: 2,000 × ₦3 × 50%	3,000
Total incremental cost of 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.

4 PRICE STRATEGIES

Section overview

- 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 (differential pricing)

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').

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: Full cost plus pricing

Eko Nigeria Limited 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		60		60
Labour	(2 hours)	120	(3 hours)	180
Expenses	(1 machine hour)	60	(1 machine hour)	60
		240		300

Budgeted production and sales are 1,500 units of product X and 1,000 units of product Y.

The sale prices for each unit of product X and product Y to give a profit margin of 20% on the full cost, if overheads are absorbed on a direct labour hour basis is calculated as follows.

Example (continued): Full cost plus pricing

Direct labour hour basis

Budgeted direct labour hours = (1,500 × 2) + (1,000 × 3) = 6,000 hours.

Overhead absorption rate = ₦900,000/6,000 = ₦150 per direct labour hour.

	Product X	Product Y
Direct costs	₦	₦
Materials	60	60
Labour	120	180
Expenses	60	60
	240	300
Absorbed overhead	300	450
Full cost	540	750
Mark-up (20%)	108	150
Selling price/unit	648	900

The budgeted profit would be (1,500 × ₦108) + (1,000 × ₦150) = ₦312,000.

Practice question **3**

A company makes two products, product A and product B. These products are both made by the same work force and in the same department.

The budgeted fixed costs are ₦2,800,000.

Variable costs per unit are as follows**:**

		Product X		Product Y
Direct costs		₦		₦
Materials		100		250
Labour	(4 hours)	200	(3 hours)	150
Expenses	(1 machine hour)	200	(1.5 machine hour)	300
		500		700

Budgeted production and sales are 2,000 units of each product.

Calculate the sale prices for each unit of product X and product Y which give a profit margin of 15% on the full cost, if overheads are absorbed on a labour hour basis or on a machine hour basis.

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.

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:

Formula: Return on investment (ROI) pricing

$$= \frac{\text{Budgeted total costs of the division + (target ROI\%} \times \text{capital employed)}}{\text{Budgeted volume}} \times 100$$

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.

Practice questions **4**

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?

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).

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.

5 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the factors that influence selling prices
- Explain and calculate price elasticity
- Derive cost and demand functions
- Calculate the price (and therefore quantity) that leads to profit maximisation
- Explain different types of pricing strategy

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

(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.

Solution **2**

1 **Step 1**: Demand curve $P = a - bQ$

a =

Demand is 300,000 if the sales price is ₦12.

Demand falls by 2,000 units for every ₦0.5 increase.

Number of increases before demand falls to zero = 300,000/2,000 = 150.

150 increases is 150 × ₦0.5 = ₦75.

Therefore the price at which the demand would be zero = ₦12 + ₦75 = ₦87.

b = ₦0.5/2000 = 0.00025

Demand curve $P = 87 - 0.00025Q$

Step 2: Revenue curve:

Multiply the demand curve by Q $R = 87Q - 0.00025Q^2$

Step 3: MR curve by differentiation $\frac{dR}{dQ} = 87 - 0.0005Q$

Step 4: (Set MR = MC)

Note that the marginal cost is the slope of the cost line

$$87 - 0.0005Q = 2$$

$$87 - 2 = 0.0005Q$$

$$Q = 170{,}000$$

Step 5: Price by substitution for Q into the demand function.

$$P = 87 - 0.00025Q$$

$$P = 87 - 0.00025(170{,}000)$$

$$P = 44.5$$

Conclusion:

Profit is maximised by selling 170,000 units for ₦44.5 per unit.

Solutions **2**

2 **Step 1**: Demand curve — $P = a - bQ$

a =

Demand is 600 if the sales price is ₦1,000.

Demand falls by 20 units for every ₦50 increase.

Number of increases before demand falls to zero = 600/20 = 30.

30 increases is 30 × ₦50 = ₦1,500.

Therefore the price at which the demand would be zero = ₦1,000 + ₦1,500 = ₦2,500.

b = ₦50/20 = ₦2.5

Demand curve	$P = 2{,}500 - 2.5Q$
Step 2: Revenue curve:	
Multiply the demand curve by Q	$R = 2{,}500Q - 2.5Q^2$
Step 3: MR curve by differentiation	$\frac{dR}{dQ} = 2{,}500 - 5Q$
Step 4: (Set MR = MC)	
Note that the marginal cost is the slope of the cost line	$2{,}500 - 5Q = 250$
	$2{,}500 - 250 = 5Q$
	$Q = 450$
Step 5: Price by substitution for Q into the demand function.	$P = 2{,}500 - 2.5Q$
	$P = 2{,}500 - 2.5(450)$
	P = ₦1,375

Conclusion:

Profit is maximised by selling 450 seats for ₦1,375 per head.

Solutions **3**

Labour hour basis

Budgeted labour hours = (2,000 × 4) + (2,000 × 3) = 14,000 hours

Overhead absorption rate = ₦2.800,000/14,000 = ₦200 per labour hour.

	Product X	Product Y
Direct costs	₦	₦
Materials	100	250
Labour	200	150
Expenses	200	300
	500	500
Absorbed overhead	800	600
Full cost	1,300	1,100
Mark-up (15%)	195	165
Selling price/unit	1,495	1,265

The budgeted profit would be (1,000 × ₦195) + (1,000 × ₦165) = ₦360,000.

Machine hour basis

Budgeted machine hours = (2,000 × 1) + (2,000 × 1.5) = 5,000 hours.

Overhead absorption rate = ₦2.800,000/5,000 = ₦560 per machine hour.

	Product X	Product Y
Direct costs	₦	₦
Materials	100	250
Labour	200	150
Expenses	200	300
	500	500
Absorbed overhead	560	840
Full cost	1,060	1,340
Mark-up (15%)	159	201
Selling price/unit	1,219	1,541

The budgeted profit would be (1,000 × ₦159) + (1,000 × ₦201) = ₦360,000.

Solutions **4**

(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)

Skills level
Performance management

CHAPTER 20

Risk and decision making

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**		
	1	**Advanced decision-making and decision-support**	
		g	Evaluate how management can deal with uncertainty in decision-making including the use of simulation, decision-trees, replacement theory, expected values, sensitivity analysis and value of perfect and imperfect information.

Exam context

This chapter explains the nature of risk and various methods which might be used to account for it in a decision making process.

By the end of this chapter, you should be able to:

- Explain the nature of risk
- Calculate expected values
- Construct decision trees and use them to solve problems
- Estimate the value of perfect information
- Explain simulation
- Carry out a simple simulation from data provided
- Perform sensitivity analysis
- Apply maximax, maximin and minimax regret criteria to make decisions

1 RISK AND UNCERTAINTY

Section overview

- The nature of risk and uncertainty
- Reducing uncertainty
- Dealing with risk and uncertainty in decision making
- Risk preference

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 in 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.

2 EXPECTED VALUES AND DECISION TREES

Section overview

- Expected values
- Expected values and decision making
- Decision trees
- Value of perfect information
- Value of imperfect information

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.

Formula: Expected value

$$\text{Expected value} = \sum px$$

Where:

p = the probability of each outcome

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: Expected value

A business entity has to decide which of three projects to select for investment. The three projects are mutually exclusive.

The projects do not involve any initial capital expenditures.

The expected annual profits from investing in each of the projects 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
Project 1	100	200	900
Project 2	0	500	600
Project 3	180	190	200

This type of table is called a 'pay-off table' or a 'pay-off matrix'. It shows all the possible 'pay-offs' or results from different possible decisions or strategies.

Project 1

	Profit	Probability	Profit × probability
Declining	100	0.4	40
Static	200	0.3	60
Expanding	900	0.3	270
			370

Project 2

	Profit	Probability	Profit × probability
Declining	0	0.4	0
Static	500	0.3	150
Expanding	600	0.3	180
			330

Project 3

	Profit	Probability	Profit × probability
Declining	180	0.4	72
Static	190	0.3	57
Expanding	200	0.3	60
			189

Based on expected values, project 1 should be selected because it has the highest EV of annual profit.

Advantages of using expected values

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

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.

2.2 Expected values and decision making

Expected values should be reliable for decision-making when:

- Probabilities can be estimated with reasonable accuracy, and
- The outcome from the decision will happen many times, and will not be a 'one-off' event.

In the following example, the estimate of monthly repair costs using expected value 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).

Example: Expected value

A company makes and sells 10,000 units of Product K each month.

Currently, when customers complain that there is one or more defects in a product the company repairs the product at its own cost.

Management is now considering selling the product for ₦6 less but no longer accepting liability for any defects.

The decision as to whether to change the policy is to be made by comparing the expected monthly cost of the new policy to the expected monthly cost of the current policy.

Expected monthly cost of new policy:

10,000 units × ₦6 = ₦60,000

Expected cost of existing policy

The estimates of defects in each product with a calculation of expected defects are given as follows:

Number of defects per product	Probability	Number of defects × probability
0	0.99	0
1	0.07	0.07
2	0.02	0.04
3	0.01	0.03
		0.14
Number of products sold per month		10,000
Expected number of defects per month		1,400

The estimate of the cost of repairing a defect with a calculation of expected cost is given as follows:

Cost of repairing one defect (₦)	Probability	Cost of repairing one defect (₦) × probability
20	0.2	4
30	0.5	15
40	0.3	12
Expected cost of each repair		31
Expected number of defects per month		1,400
Expected cost of all repairs		₦43,400

The policy should not be changed.

2.3 Decision trees

Sometimes a decision might need to be taken in two or more stages, with the second-stage decision depending on what is the outcome from the first-stage decision.

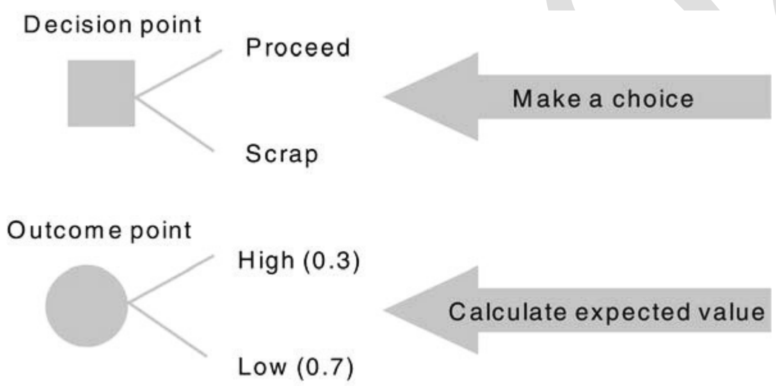
A decision tree can be drawn to provide a methodical approach to calculating the expected value. A decision tree is built to show all possible outcomes and associated probabilities. A decision tree is drawn from its “root” up to its “branches” and then, once drawn, analysed from its “branches” back to its “root”.

There are two different types of branching point in the tree:

- ❑ Decision points – as the name suggests this is a point where a decision is made
- ❑ Outcome points – an expected value is calculated here.

The following symbols are used for decision points and outcome points:

Illustration: Symbols



Example: Expected value

A company is considering whether to invest in a new project costing ₦12,000, which has an 80% chance of being successfully developed.

If it is developed successfully, the profits from the project will depend on whether the economic conditions are good or poor.

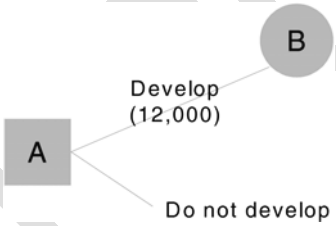
The profits expected depend on the economic conditions which are forecast as follows:

Economic conditions	Profit (loss)	Probability
Good	50,000	0.6
Poor	(20,000)	0.4

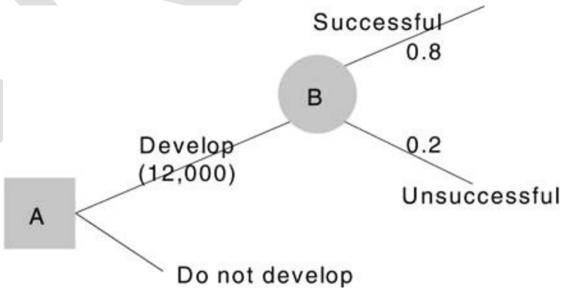
Should the company undertake the project?

Step 1: Build the tree (in this direction→)

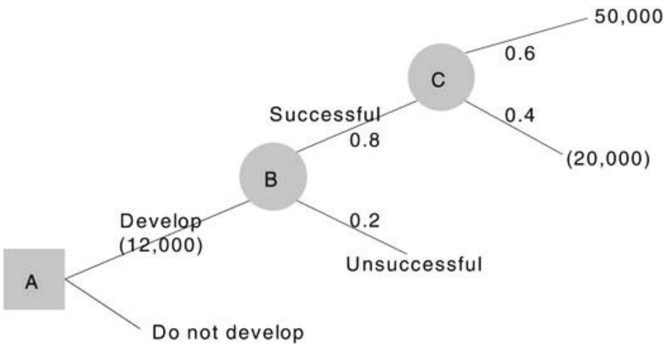
Start with the decision that is being made:



Then at point B draw the possibilities of the success or failure of the project together with the associated probabilities.



Then draw the possibilities of the different economic prospects together with the associated probabilities:



Example: Expected value (continued)

Step 2: Analyse the tree (in this direction←)

Expected value at point C:

= (0.6 ×50,000) + (0.4 ×(20,000)) = 22,000

Expected value at point B (EVB)

= (0.8 × EVC) + (0.2 × zero)

= (0.8 × 22,000) + (0.2 × zero) = 17,600

Decision at point A (EVA)

Proceed at a cost of 12,000 to earn profits with an expected value of 17,600 giving a gain of 5,600 or do not proceed for zero

The EV of the decision to invest (+ 5,600) is better than the EV of the decision not to invest (0) therefore proceed with the project

2.4 Value of perfect information

Sometimes a question might go on to ask how much a company would be willing to pay to be absolutely certain of an outcome. In other words what is the value of perfect information?

The answer to this question can be simply expressed as:

Illustration: Value of perfect information

	₦
Expected value without perfect information	X
Expected value with perfect information	X
Value of perfect information	X

Example: Value of perfect information

An organisation has offered to provide a perfect forecast of whether the future economic conditions will be good or bad.

What is the maximum amount that the company would pay for this forecast?

At point C – If the company knew that future economic conditions were good it would proceed but if it knew they were poor it would not proceed (thus avoiding the loss of ₦20,000).

The chance of the forecast being good is 60%. Therefore:

Expected value at point C (EVC)

= (0.6 ×50,000) = 30,000

Expected value at point B (EVB)

= (0.8 × EVC) + (0.2 × zero) = (0.8 × 30,000) + (0.2 × zero) = 24,000

Decision at point A (EVA)

Proceed at a cost of ₦12,000 to earn profits with an expected value of ₦24,000 would give a gain of ₦12,000.

The value of the perfect information is then calculated as follows:

	₦
Expected value with perfect information	12,000
Expected value without perfect information	5,600
Value of perfect information	6,400

2.5 Value of imperfect information

It might be possible to reduce uncertainty but not to remove it entirely. An expert might be able to make a forecast about the future but that expert might be wrong.

The approach to valuing imperfect information same as before but the calculations can be quite tricky.

Illustration: Value of imperfect information

	₦
Expected value without imperfect information	X
Expected value with imperfect information	X
Value of imperfect information	X

Example: Value of imperfect information

An organisation has offered to provide a perfect forecast of whether the future economic conditions will be good or bad.

The organisation normally achieves 85% accuracy (in other words they are wrong 15% of the time). This means that when the say the economy will be strong it may well be bad and vice versa. (Assume that the company will not proceed if a poor economy is forecast).

It is necessary to build a table of possible outcomes before solving the question.

	Economic conditions are good (60)	Economic conditions are poor (404)	
Expert forecasts the economy will be good	0.85×0.6 = 0.51	0.15×0.4 = 0.06	0.57
Expert forecasts the economy will be good	0.15×0.6 = 0.09	0.85×0.4 = 0.34	0.43
	0.6	0.4	1

Therefore there is a 57% (0.57) chance that the expert will forecast that the economy will be good.

When the expert says the economy is good he is correct 0.51 out of 0.57 times = 89.5% (0.895 times = 0.51/0.57) within that forecast. Therefore, he will be incorrect 10.5% (0,105 times) within that forecast.

The calculation of the value of imperfect information is as follows:

	₦
Expected value at point C (EVC)	
$0.895 \times 50,000$	44,750
$0.105 \times (20,000)$	(2,100)
	42,650
Probability of good verdict	0.57
	24,311
Probability of successful development	0.8
Expected value at point B	19,448
	(12,000)
Expected value at point A	7,448

The value of the imperfect information is then calculated as follows:

	₦
Expected value with imperfect information	7,448
Expected value with imperfect information	5,600
Value of imperfect information	1,848

3 SIMULATION

Section overview

- Introduction
- Monte Carlo simulation
- Multiple variables

3.1 Introduction

Simulation is the imitation of the operation of a real-world process or system over time.

An earlier chapter showed how decision trees can be used to provide a structure to allow computations of probabilities based on a series of interrelated variables. This is fine for simple situations but real life can be far more complex. Simulation is a versatile tool for providing information about the operation of complex systems.

The act of simulating something first requires that a model be developed. The model must represent the key characteristics of the selected system or process. These characteristics can be identified by observing the actual process being modelled. Once the model is built a researcher can then run it over different time frames and also introduce different variables to see what would happen.

Example: Simulation

In general, mortgage lenders run simulation models to provide insight into the state of the housing market.

The models incorporate key macroeconomic variables.

The lenders could run the model to find out what would happen to house prices if the interest rates changed by a given percentage or if incomes increased at a slower rate of inflation and so on.

The model is built to represent the system itself and a simulation represents the operation of the system over a given time period.

Running a single simulation is unlikely to provide useful information.

Once the model is set up a series of simulations can be run and the results can be used to identify an average outcome.

Uses of simulation

Simulation can be used to show the impact of alternative conditions and courses of action.

Simulation is useful in shedding light on problems where outcomes are uncertain but can be represented by known probability distribution, e.g. queues, inventory control, capital investment, replacement problems, etc.

Simulation modelling can be used to assess probabilities when there are many different variables in the situation, each with different probable outcomes and where the relationship between these variables might be complex.

3.2 Monte Carlo simulation

A Monte Carlo simulation is one that employs a random device for identifying what happens at a different point in a simulation.

A simulation model contains 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).

Example: Assigning random numbers

A company is considering launching a new product. Market research has indicated that there is a 75% chance of high sales and a 25% chance of low sales.

A random number range can be assigned to each outcome as follows:

Outcome	Probability	Cumulative probability	Random number
Low sales	25%	25%	01 to 25
High sales	75%	100%	26 to 00

It is easier to assign the random number range if a cumulative probability column is constructed first.

Once random numbers have been allocated a random number generator can be used to provide a string of numbers which in turn are used to model the outcomes.

Example: Monte Carlo simulation

Demand for inventory follows the following distribution:

Demand per day	Probability
0 – 4	32%
5 – 9	47%
10 – 14	21%

The company wishes to model demand.

Step 1: Allocate random numbers to each level of demand.

Demand per day	Probability	Cumulative probability	Random numbers
0 – 4	32%	32%	01 to 32
5 – 9	47%	79%	33 to 79
10 – 14	21%	100%	80 to 00

Step 2: Assign a value to each demand level so that it can be represented as a single number (say the mid-point)

Demand per day	Assigned value (mid-point)	Random numbers
0 – 4	2	01 to 32
5 – 9	7	33 to 79
10 – 14	12	80 to 00

Step 3: Generate a list of random numbers and select the demand level that corresponds to each number

For example the number 27 corresponds to a demand of 2 in the above table.

Step 4: Repeat for as many simulations as required. In practice this will be until the random effects of small numbers of observations have been smoothed out.

Step 5: Use the simulated values as though they are the actual values occurring in the real system, e.g. to calculate daily inventory movements.

Often more than one event will require simulation, e.g. in a purchase system both demand and supply lead times will be simulated.

Practice question **1**

A company makes 4 styles of one of its products.

The demand for these products is as follows:

Type	Probability
Economy	0.15
Normal	0.42
Super	0.28
De-luxe	0.15

Use the following random numbers to simulate the next seven demands:

25953284107266.

3.3 Multiple variables

Simulation can deal with multiple variables.

Example: Simulation

A company wishes to use simulation to provide forecasts of possible profit levels under different circumstances.

The company identifies four variables (sales volume, sales price, variable cost per unit and fixed costs) and believes that the value of each of these variables is independent of the other three variables. (Note that this would be very unlikely for sales volume and sales price).

The company has identified the possible values for each variable with their associated probability, and assigned a range of random numbers to these values as follows:

Sales volume

Units	Probability	Random number range
10,000	20%	01 – 20
20,000	50%	21 – 70
30,000	30%	71 – 00

Variable cost per unit

₦	Probability	Random number range
2	10%	01 – 10
3	30%	11 – 40
4	40%	41 – 80
5	20%	81 – 00

Sales price per unit

₦14	15%	01 – 15
₦15	40%	16 – 55
₦16	35%	56 – 90
₦17	10%	91 – 00

Fixed costs

₦200,000	85%	01 – 85
₦220,000	10%	86 – 95
₦240,000	5%	96 – 00

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 for each variable.

For example: If random numbers 14856327 are generated these become 14, 85, 63, 27 and are assigned as follows:

	Units	Probability	Random number range	Random number
Sales volume	10,000	20%	00 – 19	14
Sales price	₦16	35%	55 – 89	85
Variable cost per unit	4	40%	40 – 79	63
Fixed cost	₦200,000	85%	00 – 84	27

Example (continued): Simulation

This run gives the following result and associated probability (by multiplication):

			Probability
Sales volume	10,000		20%
Sales price	₦16	160,000	35%
Revenue			
Variable cost per unit	4	(40,000)	40%
Fixed cost		(200,000)	85%
		(80,000)	2.4%

The model is then run again and again with different sets of values for each variable obtained by generating another set of random numbers.

This generates a large number of different possible outcomes together with associated probabilities.

Repeating the simulation many times produces a probability distribution of the possible outcomes and this probability distribution can be analysed statistically.

Practice question **2**

Using the above information calculate the profit (loss) using the following set of random numbers

32841072

4 SENSITIVITY ANALYSIS

Section overview

- The nature of sensitivity analysis
- Carrying out sensitivity analysis
- Identifying the key variables with sensitivity analysis

4.1 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.

- It can be used to estimate by how much an item of cost or revenue would need to differ from their estimated values before the decision would change.
- It can be used to see whether a decision would change if estimated sales were a given percentage lower/higher than estimated or estimated costs were a given percentage 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.

4.2 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.

4.3 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: Sensitivity analysis

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 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 any one of the following occurred:

1. Sales volume is ₦10,000/₦60,000 = 16.7% less than expected
2. Sales price is ₦10,000/₦200,000 = 5% less than expected
3. Material costs are ₦10,000/₦120,000 = 8.3% more than expected
4. Labour costs are ₦10,000/₦20,000 = 50% more than expected
5. 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 20% more than expected and sales volume was also 16.7% 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.

5 MAXIMAX, MAXIMIN AND MINIMAX REGRET

Section overview

- Worst, most likely and best possible outcomes
- Constructing a pay-off table or profit table
- Maximax, maximin and minimax regret decision rules

5.1 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 pay-offs (e.g. profit values) that would result from different courses of action and different outcomes.

The example below shows:

- ❑ the different decision options in the first column (in the example below the decision relates to the size of the print run);
- ❑ the different outcomes in the top row (type of review and estimated sales in consequence); and
- ❑ the different pay-offs that result from each decision with each outcome shown in the cells.

Example: Worst, most likely and best possible outcomes

The following pay off table shows the profit or loss that would be obtained from print runs of different sizes if a book review is bad, reasonable or excellent

	Bad review (estimated sales of 1,000)	Reasonable review (estimated sales of 5,000)	Excellent review (estimated sales of 10,000)
Course of action:			
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.

5.2 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: Constructing a pay-off table

A shopkeeper must decide how many boxes of apples to buy each day. A box of apples earns revenue of ₦400 and costs ₦250.

Demand is uncertain and could vary from 30 boxes to 10 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.

A pay-off table can be constructed as follows to show the pay-offs associated with different numbers of boxes bought and different demand levels:

	Demand = 10 boxes	**Demand = 20 boxes**	**Demand = 30 boxes**
Course of action	**₦**	**₦**	**₦**
Buy 10 boxes	1,500	1,500	1,500
Buy 20 boxes	(1,000)	3,000	3,000
Buy 30 boxes	(3,500)	500	4,500

Entries in the pay-off table are calculated as follows:

Buy 10 boxes	**If demand = 10**	**If demand = 20**	**If demand = 30**
Revenue (400 per box)	4,000	4,000	4,000
Costs (250 per box)	(2,500)	(2,500)	(2,500)
Profit	1,500	1,500	1,500

Demand greater than 10 cannot be met so the profit does not change.

Example (continued)ng a pay-off table

Buy 20 boxes	**If demand = 10**	**If demand = 20**	**If demand = 30**
Revenue (400 per box)	4,000	8,000	8,000
Costs (250 per box)	(5,000)	(5,000)	(5,000)
Profit	(1,000)	3,000	3,000

Demand greater than 20 cannot be met so the profit does not change.

Buy 30 boxes	**If demand = 10**	**If demand = 20**	**If demand = 30**
Revenue (400 per box)	4,000	8,000	12,000
Costs (250 per box)	(7,500)	(7,500)	(7,500)
Profit	(3,500)	500	4,500

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, in using 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.

5.3 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'.

Example: Maximax decision rule

Ekeukwu Nigeria Limited 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

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) the 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 view that the decision-maker will identify the course of action with the highest expected return under the worst outcome. The choice is based on trying to maximise the minimum possible profit.

This decision rule might be associated with a risk-averse decision maker.

Example: Maximin decision rule

Ekeukwu Nigeria Limited 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

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 the maximin decision rule?

The 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

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, 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 is the opportunity cost of having made the wrong decision, given the actual conditions that apply in the future.

In order to use this rule a regret table must be constructed from the pay-off table. A fourth column can then be added to show the maximum regret for each course of action.

The decision rule is to select the course of action with the lowest possible 'regret'.

Example: Minimax regret decision rule

Eke ukwu Nigeria Limited 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 the minimax regret decision rule?

A regret table must be constructed.

Step 1: Draft a table with the same column and row headings as the pay-off table but add another column to identify the maximum regret shown with each course of action.

State of market	**Declining**	**Static**	**Expanding**	**Maximum regret**
	₦000	₦000	₦000	
Project 1				
Project 2				
Project 3				

Step 2: Identify the cell in each column from the pay-off that has the best pay – off (e.g. highest profit). Write a zero in the corresponding cell in the regret table.

State of market	**Declining**	**Static**	**Expanding**	**Maximum regret**
	₦000	₦000	₦000	
Project 1			0	
Project 2		0		
Project 3	0			

Interpretation:

The company would have no regret if project 3 was undertaken and the market turned out to be declining.

The company would have no regret if project 2 was undertaken and the market turned out to be static.

The company would have no regret if project 1 was undertaken and the market turned out to be expanding.

Example (continued): Minimax regret decision rule

Step 3: Compare the pay-off in each cell to best pay-off in that column. Write the difference in the corresponding cell in the regret table. These are the regret values.

State of market	Declining	Static	Expanding	Maximum regret
	₦000	₦000	₦000	
Project 1	280	380	0	
Project 2	130	0	350	
Project 3	0	310	750	

Interpretation:

The company would have no regret if project 3 was undertaken and the market turned out to be declining but if Project 1 was selected the company would be worse off by ₦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.

Similarly, 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.

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. The company would have no regret if project 2 was undertaken but If Project 1 is selected the regret will be ₦380,000 (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.

Similar comments could be made in respect of the expanding market.

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).

Step 4: Write the maximum regret for each option in the right-hand column and 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.

State of market	Diminishing	Static	Expanding	Maximum regret
	₦000	₦000	₦000	₦000
Project 1	280	380	0	380
Project 2	130	0	350	350
Project 3	0	310	750	750

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.

Practice questions **3**

A shopkeeper must decide how many boxes of apples to buy each day. A box of apples earns contribution of ₦400 and costs ₦250.

Demand is uncertain and could vary from 30 boxes to 10 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.

The following pay-off table has been constructed:

	Demand = 10 boxes	**Demand = 20 boxes**	**Demand = 30 boxes**
Course of action	**₦**	**₦**	**₦**
Buy 10 boxes	1,500	1,500	1,500
Buy 20 boxes	(1,000)	3,000	3,000
Buy 30 boxes	(3,500)	500	4,500

How many boxes should the storekeeper purchase if the decision is based on:

a) the maximax decision rule?

b) the maximin decision rule?

c) the minimax regret decision rule?

6 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the nature of risk
- Calculate expected values
- Construct decision trees and use them to solve problems
- Estimate the value of perfect information
- Explain simulation
- Carry out a simple simulation from data provided
- Perform sensitivity analysis
- Apply maximax, maximin and minimax regret criteria to make decisions

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

Assign random numbers to categories

Category	Probability	Cumulative probability	Random number range
Economy	0.15	0.15	00-14
Normal	0.42	0.57	15-56
Super	0.28	0.85	57-84
De-luxe	0.15	1.00	85-99

Simulation of next seven demands

Run	1	2	3	4	5	6	7
Random number	25	95	32	84	10	72	66
Category	N	D	N	S	E	S	S

Solutions **2**

This run gives the following result and associated probability (by multiplication):

			Probability
Sales volume	30,000		30%
Sales price	₦16		35%
Revenue		**480,000**	
Variable cost per unit	₦2	(60,000)	10%
Fixed cost		(220,000)	10%
Profit		#200,000	0. 105%

Solutions **3**

Pay off table	**Demand = 10 boxes**	**Demand = 20 boxes**	**Demand = 30 boxes**
Course of action	**₦**	**₦**	**₦**
Buy 10 boxes	1,500	1,500	1,500
Buy 20 boxes	(1,000)	3,000	3,000
Buy 30 boxes	(3,500)	500	4,500

a) Maximax decision rule:

30 boxes would be bought as this allows for the biggest possible pay off.

b) Maximin decision rule:

10 boxes would be bought as this would maximise the lowest possible pay-offs associated with each course of action at the lowest demand level.

c) Minimax regret decision rule

Regret table	**Demand = 10 boxes**	**Demand = 20 boxes**	**Demand = 30 boxes**	**Maximum regret**
Course of action	**₦**	**₦**	**₦**	**₦**
Buy 10 boxes	0	1,500	3,000	3,000
Buy 20 boxes	2,500	0	1,500	2,500
Buy 30 boxes	5,000	2,500	0	5,000

20 boxes should be bought.

Skills level
Performance management

CHAPTER 21

Working capital management

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**		
	2	**Working capital management**	
		a	Discuss the nature, elements and importance of working capital.
		b	Calculate and explain the cash operating cycle.

Exam context

This chapter explains the nature, elements and importance of working capital and different ways in which it might be financed.

By the end of this chapter, you should be able to:

- Define working capital and its components.
- Explain the objectives of working capital management
- Explain and evaluate a cash operating cycle
- Define and use ratios used in working capital management
- Define and be able to identify the characteristics of overtrading

1 FINANCING WORKING CAPITAL

Section overview

- The nature and elements of working capital
- The objectives of working capital management
- Investment in working capital
- Determining the level of working capital investment
- Financing working capital: short-term or long-term finance?

1.1 The nature and elements of working capital

Working capital is the capital (finance) that an entity needs to support its everyday operations. To operate a business, an entity must invest in inventories and it must sell its goods or services on credit. Holding inventories and selling on credit costs money.

Some of the finance required for operations is provided by taking credit from suppliers. This means that the suppliers to an entity are helping to support the business operations of that entity. Some short-term operating finance might also be obtained by having a bank overdraft.

Cash and short-term investments are also elements of working capital. Some cash might be held for operational use, to pay liabilities. Surplus cash in excess of operational requirements might be invested short-term to earn some interest.

Working capital can therefore be defined as the net current assets (or net current operating assets) of a business. (This is the net concept and is adopted in this chapter. There is also the gross concept which views working capital as a firm's total investment in current assets).

The total investment in working capital is calculated as:

Illustration: Working capital

Current assets:	₦
Inventory	X
Trade receivables	X
Short-term investments	X
Cash	X
	X
Minus current liabilities:	
Bank overdraft	X
Trade payables	X
Other current liabilities	X
	(X)
Working capital	X

1.2 The objectives of working capital management

The management of working capital is an aspect of financial management, and is concerned with:

- Ensuring that the investment in working capital is not excessive;
- Ensuring that enough working capital is available to support operating activities.

Note on surplus cash and short-term investments. For entities with surplus cash, there is also the management problem of how to use the surplus. If the surplus is only temporary, it might be invested in short-term financial assets. The aim should be to select investments that provide a suitable return without undue risk, and that can be converted back into cash without difficulty when the money is eventually required. The management of surplus cash is discussed in more detail in a later chapter.

Avoiding excessive working capital

An aim of working capital management should be to avoid excessive investment in working capital. As stated earlier, working capital is financed by long-term capital (equity or debt) which has a cost.

It can be argued that it is essential to hold inventory and to offer credit to customers, so investment in current assets is unavoidable. However, the investment in inventory and trade receivables does not provide any additional financial return. So investment in working capital has a cost without providing any direct financial return.

Avoiding liquidity problems

On the other hand, a shortage of working capital might result in liquidity problems due to having insufficient operational cash flows to pay liabilities when payment is due. Operational cash flows come into a business from the sale of inventories and payment by customers: inventory and trade receivables are therefore a source of future cash income. These must be sufficient for the payment of liabilities.

A company that has insufficient working capital might find that it has to make payments to suppliers (or other short-term liabilities) but does not have enough cash or bank overdraft facility to do so, because its current assets are insufficient to generate the cash inflows that are needed and when payment falls due.
Liquidity problems, when serious, can result in insolvency.

The conflict of objectives with working capital management

A conflict of objectives therefore exists with working capital management. Over-investment should be avoided, because it reduces profits or returns to shareholders. Under-investment should be avoided because it creates a liquidity risk. These issues are explained in more detail below:

1.3 Investment in working capital

The total amount that an entity invests in working capital should be managed carefully.

- The investment should not be too high, with excessive inventories and trade receivables. If the investment is too high, the entity is incurring a cost (the interest cost of the investment) without obtaining any benefits.
- The investment should not be too low. In particular the entity should not rely, for its financing of operations, on large amounts of trade credit from suppliers or a large bank overdraft. If working capital is too low, there could be a risk of having insufficient cash and liquidity.

The amount to invest in working capital depends on the trade-off between:

- The benefits of having sufficient finance to support trading operations without excessive liquidity risk, and
- The costs of financing the working capital.

Benefits of investing in working capital

There are significant benefits of investing in working capital:

- Holding inventory allows the entity to supply its customers on demand.
- Entities are expected by many customers to sell to them on credit. Unless customers are given credit (which means having to invest trade receivables) they will buy instead from competitors who will offer credit.
- It is also useful for an entity to have some cash in the bank to meet demands for immediate payment.

Disadvantages of excessive investment in working capital

However, money tied up in inventories, trade receivables and a current bank account earns nothing. Investing in working capital therefore involves a cost. The cost of investing in working capital is the reduction in profit that results from the money being invested in inventories, receivables or cash in the bank account, rather than being invested in wealth-producing assets and long-term projects.

The cost of investing in working capital can be stated simply as:

Average investment in working capital × Annual cost of finance (%)

= Annual cost of working capital investment.

1.4 Determining the level of working capital investment

The target level of working capital investment in an organisation is a policy decision which is dependent on several factors including:

- The length of the working capital cycle
- Management attitude to risk

The length of the working capital cycle

Different industries will have different working capital requirements. The working capital cycle measures the time taken from the payment made to suppliers of raw materials to the payments received from customers. In a manufacturing company this will include the time that:

- Raw materials are held in inventory before they are used in production
- The product takes in the production process
- Finished goods are held in inventory before being purchased by a customer.

The working capital cycle will also be affected by the **terms of trade**. This is the amount of credit given to customers compared to the credit taken from suppliers. In a manufacturing company it may be normal practise to give customers lengthy periods of credit.

The level of working capital in manufacturing industry is therefore likely to be higher than in retailing where goods are bought in for re-sale and may not be held in inventory for a very long period and where most sales are for cash rather than on credit terms.

Management attitude to risk

High levels of working capital are expensive but low levels of working capital are high risk.

- An aggressive working capital policy will seek to keep working capital to a minimum. Low finished goods inventory will run the risk that customers will not be supplied and will instead buy from customers. Low raw material inventory may lead to stock-outs (or 'inventory-outs') and therefore high costs of idle time or expensive replacement suppliers having to be found. Tight credit control may alienate customers and taking long periods of credit from suppliers may run the risk of them refusing to supply on credit at all. However low levels of working capital will be cheap to finance and if managed effectively could increase profitability.
- A conservative working capital policy aims to keep adequate working capital for the organisation's needs. Inventories are held at a level to ensure customers will be supplied and stock-outs will not occur. Generous terms are given to customers which may attract more customers. Suppliers are paid on time.

Risk-seeking managers may prefer to follow a more aggressive working capital policy and risk-averse managers a more conservative working capital policy.

1.5 Financing working capital: short-term or long-term finance?

Working capital may be permanent or fluctuating.

- **Permanent working capital** refers to the minimum level of working capital which is required all of the time. It includes minimum levels of inventories, trade receivables and trade payables.
- **Fluctuating working capital** refers to working capital which is required at certain times in the trade cycle. For example it may be economic for companies to purchase raw materials in bulk. The finance required to fund the purchase of the order will be a temporary requirement because eventually the raw material will be made into a product and sold to customers. The levels of fluctuating working capital may be higher if companies have seasonal demand. For example manufacturers of skiing equipment might build up inventories of products before the winter season.

Long-term finance, such as equity and debt, is expensive but low risk. Short-term finance is less expensive but there is a higher risk of it being withdrawn. The type of financing used within the business may depend on management attitude to risk.

- **Aggressive funding policies** use long-term finance to fund non-current assets and short-term finance to fund all working capital requirements
- **Matching funding policies** use long-term finance to fund non-current assets and permanent working capital. Fluctuating working capital is funded using short-term finance.
- **Conservative funding policies** use long-term finance to fund non-current assets, permanent working capital and a proportion of fluctuating working capital. Minimal short-term finance is used.

The benefits of using short-term finance (trade payables and a bank overdraft) rather than long-term finance are as follows:

- **Lower cost**. Trade credit is the cheapest form of short-term finance – it costs nothing. The supplier has provided goods or services but the entity has not yet had to pay.
- **Much more flexible**. A bank overdraft is variable in size, and is only used when needed.

However, although there are the benefits of low cost and flexibility with short-term finance, there are also risks in relying too much on short-term finance.

- Short-term finance runs out more quickly and has to be renewed. Suppliers must be asked for trade credit every time goods or services are bought from them.
- A bank overdraft facility is risky, because the bank has the right to demand immediate repayment of an overdraft at any time. When an entity needs a higher bank overdraft, this can often be the time that the bank decides to withdraw the overdraft facility.

2 CASH OPERATING CYCLE

Section overview

- The nature of the cash operating cycle
- Elements in the cash operating cycle
- Calculating the inventory turnover period
- Calculating the average collection period
- Calculating the average payables period
- Analysing the cash operating cycle
- Changes in the cash flow cycle and implications for operating cash flow

2.1 The nature of the cash operating cycle

An important way of assessing the adequacy of working capital and the efficiency of working capital management is to calculate the length of the cash operating cycle.

This cycle is the average length of time between paying suppliers for goods and services received to receiving cash from customers for sales of finished goods or services.

The cash operating cycle is linked to the business operating cycle. A business operating cycle is the average length of time between obtaining goods and services from suppliers to selling the finished goods to suppliers.

A cash operating cycle differs significantly for different types of business. For example, a company in a service industry such as a holiday tour operator does not have much inventory, and it might collect payments for holidays from customers in advance. The time between paying suppliers and receiving cash from customers might be very short.

In contrast a manufacturing company might have to hold large inventories of raw materials and components, work in progress and finished goods, and most of its sales will be on credit so that it has substantial trade receivables too. The time between paying for raw materials and eventually receiving payment for finished goods could be lengthy.

Retail companies have differing cash operating cycles. Major supermarkets have a very short cash operating cycle, because they often sell goods to customers before they have even paid their suppliers for them. This is because supermarkets enjoy very fast turnover of most items and their sales are for cash. In contrast a furniture retailer might hold inventory for a much longer time before selling it, and some customers might arrange to pay for their purchases in instalments.

Cash operating cycle and working capital requirements

The cash operating cycle is a key factor in deciding the minimum amount of working capital required by a company. A longer cash operating cycle means a larger investment in working capital.

The cash operating cycle, and each of the elements in the cycle, must be managed to ensure that the investment in working capital is not excessive (i.e. the cash cycle is not too long) nor too small (i.e. the cash cycle is too short, perhaps because the credit period taken from suppliers is too long).

2.2 Elements in the cash operating cycle

There are three main elements in the cash operating cycle:

- The average length of time that inventory is held before it is used or sold
- The average credit period taken from suppliers
- The average length of credit period taken by (or given to) credit customers.

A cash cycle or operating cycle is measured as follows.

Illustration: Cash operating cycle

	Days/weeks/ months
Average inventory holding period	X
Average trade receivables collection period	X
	X
Average period of credit taken from suppliers	(X)
Operating cycle	X

The working capital ratios and the length of the cash cycle should be monitored over time. The cycle should not be allowed to become unreasonable in length, with a risk of over-investment or under-investment in working capital.

Measuring the cash operating cycle: a manufacturing business

For a manufacturing business, it might be appropriate to calculate the inventory turnover period as the sum of three separate elements:

- the average time raw materials and purchased components are held in inventory before they are issued to production (raw materials inventory turnover period), plus
- the production cycle (which relates to inventories of work-in-progress), plus
- the average time that finished goods are held in inventory before they are sold (finished goods inventory turnover).

2.3 Calculating the inventory turnover period

For a company in the **retail sector or service sector** of industry, the average inventory turnover period is normally calculated as follows:

Formula: Average time for holding inventory (Inventory holding period or average inventory days)

$$\text{Average inventory days} = \frac{\text{Inventory}}{\text{Cost of sales}} \times 365 \text{ days}$$

If possible, average inventory should be used to calculate the ratio because the year-end inventory level might not be representative of the average inventory in the period. Average inventory is usually calculated as the average of the inventory levels at the beginning and end of the period. However, the year-end inventory should be used when opening inventory is not given and average inventory cannot be calculated.

For companies in the retailing or service sector, the cost of sales is normally used 'below the line' in calculating inventory turnover. However, if the value for annual purchases of materials is given, it might be more appropriate to use the figure for purchases instead of cost of sales.

For a **manufacturing company**, the total inventory turnover period is the sum of the raw materials turnover period, production cycle and finished goods turnover period, calculated as follows:

Illustration: Inventory turnover period for a manufacturing company

	Days
Raw material = (Average raw material inventory/Annual raw material purchases) × 365 days	X
Production cycle = (Average WIP/Annual cost of sales) × 365 days	X
Finished inventory = (Average finished inventory/Annual cost of sales) × 365 days	(X)
Total	X

Inventory turnover and the turnover period

Inventory turnover is the inverse of the inventory turnover period.

- ❑ If the average inventory turnover period is 2 months, this means that inventory is 'turned over' (used) on average six times each year (= 12 months/2 months).
- ❑ If the inventory turnover is 8 times each year, we can calculate the average inventory turnover period as 1.5 months (= 12 months/8) or 46 days (= 365 days/8).

2.4 Calculating the average collection period

The average period for collection of receivables can be calculated as follows:

Formula: Average time to collect (average collection period or average receivables days)

$$\text{Average time to collect} = \frac{\text{Trade receivables}}{\text{Credit sales}} \times 365 \text{ days}$$

When normal credit terms offered to customers are 30 days (i.e. the customer is required to pay within 30 days of the invoice date), the average collection period should be about 30 days. If it exceeds 30 days, this would indicate that some customers are taking longer to pay than they should, and this might indicate inefficient collection procedures for receivables.

2.5 Calculating the average payables period

The average period of credit taken from suppliers before payment of trade payables can be calculated as follows:

Formula: Average time to pay suppliers (Average payables days)

$$\text{Average time to pay} = \frac{\text{Trade payables}}{\text{Purchases}} \times 365 \text{ days}$$

The average payment period should be close to the normal credit terms offered by suppliers in the industry.

- If the average payment period is much shorter than the industry average, this might suggest that the company has not negotiated reasonable credit terms from suppliers, or that invoices are being paid much sooner than necessary, which is inefficient working capital management.
- If the average payment period is much longer than the industry average, this might indicate that the company has succeeded in obtaining very favourable credit terms from its suppliers. Alternatively, it means that the company is taking much longer credit than it should, and is failing to comply with its credit terms. This might be an indication of either cash flow problems or (possibly) unethical business practice.

Example:

Extracts from the statement of financial position (balance sheet) and income statement of a company are set out below.

	₦
Inventories:	
Raw materials	864,000
Work in progress	448,128
Finished goods	1,567,893
Trade receivables	1,425,600
Trade payables	604,800
Annual purchases	1,745,000
Annual cost of sales	5,272,128
Annual sales	5,802,400

Required

Calculate the length of the cash operating cycle for the company.

Answer

Item		Days
Raw material turnover	(864,000/1,745,000) × 365 days	181
Production cycle	(448,128/5,272,128) × 365 days	31
Finished goods turnover	(1,567,893/5,272,128) × 365 da	109
Credit period given to customers	(1,425,600/5,802,400) × 365 da	90
		411
Minus:		
Credit period from suppliers	(604,800/1,745,000) × 365 days	(127)
Cash operating cycle		284

In this example, it takes the company 284 days on average from paying for the goods and services that go into making its products, before it gets paid the cash from the sales. If the cash cycle gets longer, this would mean having to find ever-increasing amounts to finance the investment in inventory and trade receivables, and it could result in serious cash flow and liquidity problems for the business.

2.6 Analysing the cash operating cycle

The cash operating cycle can be analysed to assess whether the total investment in working capital is too large or possibly too small. The analysis can be made by comparing each element of the cash operating cycle, and the cash operating cycle as a whole, with:

- the cash operating cycle of other companies in the same industry
- the company's own cash operating cycle in previous years, to establish whether it is getting longer or shorter.

Comparisons with other companies in the industry

As a general rule, the inventory turnover period, average collection period and average payment period should be about the same for all companies operating in the same industry. If there are differences, there might be reasons. For example a company with an unusually large proportion of sales to other countries might have a longer average collection period because of the longer time that it takes to deliver goods to customers.

If it is not possible to explain significant differences in any ratio between a company's own turnover periods and the industry average, the differences might be due to inefficient working capital management (or possibly efficient management). For example an unusually long inventory turnover period compared with the industry average might indicate inefficiency due to excessive holding of inventory. Slow-moving inventory might also indicate that a write off of obsolete inventory might be necessary at some time in the near future.

Comparisons with previous years: trends

There might be a noticeable trend over time in a company's turnover ratios from one year to the next. A trend towards longer or shorter turnover and cycle times should be investigated.

A particular cause for concern might be a trend towards longer inventory turnover periods and longer average collection times, which might be an indication of excessive inventories (inefficient inventory management) or inefficient collection procedures for trade payables.

Example:

In the financial year just ended, a retailing company had closing inventory costing ₦425,000 and sales in the year were ₦4.5 million. In the previous year, closing inventory was ₦320,000 and sales during that year were ₦4.3 million.

In this example, end-of-year inventory levels are used to calculate inventory turnover periods, because average inventory for the previous year cannot be calculated.

Average inventory turnover in the current year:

$$= ₦425{,}000/₦4.5 \text{ million} \times 365 = 34 \text{ days.}$$

Average inventory turnover in the previous year:

$$= ₦320{,}000/₦4.3 \text{ million} \times 365 = 27 \text{ days.}$$

The average turnover period has increased by 7 days. This might have implications for profitability. If the turnover period had remained 27 days in the current year, closing inventory would be ₦333,000 (= 27/365 × ₦4.5 million). This is ₦95,000 less than the actual inventory level, suggesting that with better inventory management, working capital might have been lower by about ₦95,000.

If the higher inventory level at the end of the year indicates that it is taking longer to sell inventory, this might suggest that the inventory will not be sold unless the retail company has a sale and the goods are sold at a low gross profit margin.

2.7 Changes in the cash cycle and implications for operating cash flow

When there are changes in the length of the cash operating cycle, this has implications for cash flow as well as working capital investment.

- A longer cash operating cycle, given no change in sales or the cost of sales, increases the total investment in working capital. An increase in the inventory turnover period means more inventory and an increase in the average collection period means more trade receivables. A reduction in the average payables period means fewer trade payables, which also increases working capital.
- An increase in working capital reduces operational cash flows in the period.

The reverse is also true. A shorter cash operating cycle results in less working capital investment, and the fall in working capital increases operating cash flows in the period.

3 OTHER WORKING CAPITAL RATIOS

Section overview

- Liquidity
- Liquidity ratios
- Sales revenue net working capital ratio

The previous section explained the cash operating cycle and the relevance of turnover periods for inventory, trade receivables and trade payables for cash flow and the size of investment in working capital.

Other working capital ratios can also be used to analyse whether a company has too much or too little working capital, and whether it has adequate liquidity.

3.1 Liquidity

Liquidity for an entity means having access to sufficient cash to meet all payment obligations when they fall due.

The main sources of liquidity for a business are:

- Cash flows from operations: a business expects to make its payments for operating expenditures out of the cash that it receives from operations. Cash comes in when customers eventually pay what they owe (and from cash sales).
- Holding 'liquid assets': these are assets that are either in the form of cash already (money in a bank account) or are in the form of investments that can be sold quickly and easily for their fair market value.
- Access to a 'committed' borrowing facility from a bank (a 'revolving credit facility'). Large companies are often able to negotiate an arrangement with a bank whereby they can obtain additional finance whenever they need it.

A key element of managing working capital is to make sure the organisation has sufficient liquidity to meet its payment commitments as they fall due. Having sufficient liquidity is a key to survival in business.

If there is insufficient liquidity, then even if the entity is making profits, it will go out of business. If the entity cannot pay what it owes when the payment is due, legal action will probably be taken to recover the unpaid money and the entity will be put into liquidation. In practice, banks are usually the unpaid creditors who put illiquid entities into liquidation.

The liquidity of a business entity can be assessed by analysing:

- Its liquidity ratios; and
- The length of its cash operating cycle (explained earlier).

3.2 Liquidity ratios

A liquidity ratio is used to assess the liquidity of a business. There are two liquidity ratios:

Formula: Current ratio

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

Formula: Quick ratio

$$\text{Quick ratio} = \frac{\text{Current assets excluding inventory}}{\text{Current liabilities}}$$

You should use the values in the **closing balance sheet** to calculate these two ratios.

The purpose of a liquidity ratio is to compare the amount of liquid assets held by a company with its current liabilities. This is because the money to pay the current liabilities should be expected to come from the cash flows generated by the liquid assets.

Unlike the cash operating cycle ratios, the liquidity ratios include all current assets (including cash and short-term investments) and all current liabilities (including any bank overdraft and current tax payable).

Analysing the liquidity ratios

If the liquidity ratios are too high, this indicates that there is too much investment in working capital. If the liquidity ratios are low, this indicates that the company might not have enough liquidity, and might be at risk of being unable to settle its liabilities when they fall due. So how do we assess whether the liquidity ratios are too high or too low.

The liquidity ratios of a company may be compared with:

- the liquidity ratios of other companies in the same industry, to assess whether the company's liquidity ratios are higher or lower than the industry average or norm and
- changes in the company's liquidity ratios over time and whether its current assets are rising or falling in proportion to its current liabilities.

It has sometimes been suggested that there 'ideal liquidity ratios and that:

- the 'ideal' current ratio might be 2:1.
- the 'ideal' quick ratio might be 1:1.

When the ratios are below these 'ideal' levels, management might need to consider how liquidity might be improved.

However, these 'ideal' ratios are only a very general guide.

- The 'normal' or 'acceptable' liquidity ratios vary significantly between different industries. The ideal liquidity ratios depend to a large extent on the 'ideal' or 'normal' turnover periods for inventory, collections and payments to suppliers.

- ❑ A high ratio might be attributable to an unusually large holding of cash. When a company has surplus cash or short-term investments, this might be temporary and the company might have plans for how the cash will be used in the near future.

The most appropriate way of using liquidity ratios is probably to monitor changes in the ratio over time. When the ratios fall below a ‘safe‘level, and continue to fall, the entity might well have a serious liquidity problem.

Note

Which of the two liquidity ratios is more significant? The answer to this question is that it depends on the normal speed of turnover for inventory. If inventory is held only for a short time before it is used or sold, the current ratio is probably a more useful ratio, because inventory is a liquid asset (convertible into cash within a short time).

On the other hand, if inventory is slow moving, and so fairly illiquid, the quick ratio is probably a better guide to an entity’s liquidity position.

Example:

	20X7	**20X8**	**20X9**
	₦m	**₦m**	**₦m**
Inventory	130	240	225
Trade receivables	245	312	400
Cash	100	54	23
Current assets	475	606	648
Current liabilities	(200)	(300)	(450)
Net current assets	275	306	198

In addition, the following information is available:

Credit sales		1,500	1,530
Cost of goods sold		1,120	1,200

Required

Assess the entity’s liquidity position, using:

- ❑ inventory turnover time
- ❑ the average collection time
- ❑ liquidity ratios.

Answer

When the information is available, you should use average inventory and average trade receivables for the year, rather than the year-end value.

It is assumed that average values for the year are the average of the beginning–of-year and end-of-year values.

Inventory turnover

Average inventory:

20X9 = (240 + 225)/2 = 232.5

20X8 = (130 + 240)/2 = 185.0

Inventory turnover:

20X9 = (232.5/1,200) × 365 days = 71 days

20X8 = (185/1,120) × 365 days = 60 days.

Inventory turnover was slower in 20X9 than in 20X8. This could be an indication of problems with inventory management, as well as deteriorating liquidity.

The slower inventory turnover implies that we are not converting the stock to cash as quickly as before. As a result more money is being tied up in working capital.

Average time for customers to pay

Average trade receivables:

20X9 = (312 + 400)/2 = 356.0

20X8 = (245 + 312)/2 = 278.5

Average time for credit customers to pay

20X9 = (356/1,530) × 365 days = 85 days

20X8 = (278.5/1,500) × 365 days = 68 days

As with inventory turnover, the payment time for trade receivables is worsening and trade receivables are not converting to cash as quickly as before. This implies that the liquidity position is deteriorating.

Liquidity ratios

Current ratio

	20X7	20X8	20X9
Current assets	475	606	648
Current liabilities (÷)	200	300	450
	2.38 times	2.02 times	1.44 times

Answer (continued)

The liquidity position of the business, as measured by the current ratio, has become much worse in 20X9 compared with 20X8 and 20X6. It could well be getting worse continually. Creditor payments were covered by nearly 2.5 times in 20X7. By 20X9, the cover had shrunk to around 1.5 times. This indicates a potential problem for the business, possibly in the near future.

However, before making this judgement you should want to know the reasons for the deterioration in inventory turnover time and the average time for customers to pay, because these will be linked to the deterioration in the current ratio.

Quick ratio

	20X7	20X8	20X9
Current assets	345	366	423
Current liabilities (÷)	200	300	450
	1.73 times	1.22 times	0.94 times

This ratio confirms the analysis. The liquidity position is getting worse. However, a ratio of 0.94 is only just below the 'ideal' quick ratio of 1.0 time; therefore further analysis should be carried out to assess the problem, and what must be done to resolve it. It might be appropriate to prepare a cash flow forecast for the next few months, to assess the possible need for cash in the near future.

3.3 Sales revenue: net working capital ratio

The sales revenue: net working capital ratio is another ratio that might be used to assess whether the investment in working capital is too large or insufficient. This is because it might be assumed that the amount of working capital should be proportional to the value of annual sales, because there should be a certain amount of working capital to 'support' a given quantity of sales.

'Net working capital' is simply total current assets less total current liabilities.

Example: Sales revenue: net working capital ratio

Last year a company had sales revenue of ₦20 million. Its average current assets were ₦2.8 million and its average current liabilities were ₦1.1 million.

Last year its sales: net working capital ratio was 12.5 times. The current average sales: net working capital ratio for other companies in the same industry is 12.4 times.

Current year

Net working capital = ₦1.7 million

Sales: net working capital ratio = ₦20 million/₦1.7 million = 11.8 times

Analysis

The company's sales: net working capital ratio has fallen since the previous year. It is now below the industry average.

A lower ratio means that working capital is now larger relative to sales revenue. This might be an indication that the investment in working capital is getting too large.

If the ratio had remained at 12.5, the same as last year, working capital would be ₦1.6 million (= ₦20 million/12.5). This suggests that working capital might now be about ₦100,000 more than necessary.

If the ratio had been 12.4, the industry average, working capital would be about ₦1.61 million (= ₦20 million/12.4). This suggests that working capital might now be about ₦90,000 more than necessary.

This analysis is not necessarily conclusive, but it might be sufficient to justify a closer investigation into working capital investment, the reasons for the change in the ratio and whether measures might be taken to improve the management of working capital (and in doing so increase the ratio back towards the industry average).

4 OVERTRADING

Section overview

- The meaning of overtrading
- Symptoms of overtrading
- Consequences of overtrading and possible remedial action

4.1 The meaning of overtrading

Overtrading means carrying on an excessive volume of trading in relation to the amount of long-term capital invested in the business. A company that is overtrading has inadequate capital for the volume of sales revenue it is earning.

Although it is possible for any business entity to overtrade, it is probably most common in small companies that are now expanding rapidly, with a very high rate of sales growth.

4.2 Symptoms of overtrading

A company that is overtrading will usually show most of the following symptoms.

- A high rate of annual sales growth.
- Low profitability. The company might be reducing its gross profit margin in order to grow sales quickly. As it grows, the company might also incur much higher expenses, such as higher administration costs, which reduce the net profit margin.
- Because profitability is low, retained profits are also low. Retained profits are an important source of new equity, but the company is not increasing its equity investment quickly enough because there are insufficient profits.
- The growth in sales revenue will also mean a large increase in inventory and trade receivables. Working capital management might become less efficient, because systems that operated well when the company was small (such as inventory control and collection of receivables) no longer operate efficiently when the company is larger. Turnover times for inventory and collections might increase.
- The company might also need to acquire some new non-current assets to support the growth in sales volume.
- The growth in assets has to be financed by equity and liabilities. Because profits are low, equity capital increases only by a small amount. The growth in assets is therefore financed by liabilities and in particular by current liabilities.
- The increase in current liabilities takes the form of:
  - a much longer time to pay suppliers, so that the average payments period increases substantially and trade payables in the statement of financial position (balance sheet) are much higher
  - a very big increase in its bank overdraft.

Example: Overtrading

Vesuvius is a rapidly-growing company. Its summarised financial statements for the current financial year (just ended) and the previous year are as follows:

Summarised income statements

	Current year	Previous year
	₦000	₦000
Revenue	4,000	3,000
Cost of sales	2,400	1,500
Gross profit	1,600	1,500
Operating expenses	1,550	1,250
Net profit	50	250

Summarised statements of financial position

	Current year		Previous year	
	₦000	₦000	₦000	₦000
Non-current assets		2,000		1,800
Current assets				
Inventory	600		300	
Trade receivables	650		330	
Cash	nil		20	
		1,250		650
Total assets		3,250		2,450
Equity and liabilities				
Share capital		1,800		1,800
Retained earnings		500		450
		2,300		2,250
Current liabilities				
Trade payables	450		200	
Bank overdraft	500		nil	
		950		200
		3,250		2,450

This is a company that displays all the symptoms of overtrading.

Sales in the current year are 33.3% higher than in the previous year. This is a very high rate of sales growth.

Profits are low. The gross profit margin has fallen to 40% in the current year compared with 50% in the previous year. The company might be reducing its sales prices in order to sell more goods.

Net profit fell from ₦250,000 in the previous year to just ₦50,000 in the current year. All this profit has been retained, but the growth in equity and reserves is small in relation to the growth in the size of the business.

Example (continued): Overtrading

There has been a big increase in inventory, by 100%. The average turnover period for inventory increased to 91 days in the current year [(600/2,400) × 365] from 73 days in the previous year [(300/1,500) × 365].

The average time to collect trade receivables has also increased substantially, by ₦320,000 or 97%. The average collection period was 59 days in the current year [(650/4,000) × 365] but only 40 days in the previous year [(330/3,000) ×365].

There has been some increase in non-current assets, which has been largely financed by current liabilities – probably bank overdraft.

There has been a very large increase of ₦250,000 or 125% in trade payables, as well as a movement from a cash surplus of ₦20,000 to a bank overdraft of ₦500,000. The increase in trade payables is due not only to the growth in sales volume and cost of sales, but also to an increase in the average payment period to 68 days in the current year [(450/2,400) × 365] from 49 days in the previous year [(200/1,500) ×365].

4.3 Consequences of overtrading and possible remedial action

The consequences of overtrading are eventual insolvency, unless remedial measures are taken. Insolvency will occur if sales continue to grow and overtrading continues because a company cannot finance its growth in business indefinitely with growth in current liabilities.

In the previous example, the company's bank will eventually refuse to allow any more overdraft, and might even withdraw the existing overdraft facility if it believes that the company cannot repay what it already owes. The company's suppliers will also eventually refuse to allow longer credit.

Overtrading therefore eventually leads to inadequate liquidity due to insufficient long-term capital funding.

Remedial action

The action to restore the financial position when a company is overtrading is either to increase capital or reduce the volume of business that the company is conducting. The aim should be to achieve a better ratio of long-term capital to sales, and a suitable level of working capital investment.

One way of increasing long-term capital is to increase profits. A company that is overtrading should look for ways of improving both the gross profit and net profit margins, by cutting costs or increasing sales prices. Higher profits will enable the company to improve its operating cash flows and also to increase its equity capital by retaining more profit.

However, a problem with trying to resolve a problem of overtrading by improving profits is that the company might not have time to build up cash flows and profits soon enough. The bank might withdraw its overdraft facility without notice, making the company insolvent.

5 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Define working capital and its components.
- Explain the objectives of working capital management
- Explain and evaluate a cash operating cycle
- Define and use ratios used in working capital management
- Define and be able to identify the characteristics of overtrading

Skills level
Performance management

CHAPTER 22

Inventory management

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**			
	2	**Working capital management**		
		a	Discuss the nature, elements and importance of working capital.	
		c	Evaluate and discuss the use of relevant techniques in managing working capital in relation to:	
			i	Inventory (including economic order quantity model and Just-in-Time techniques)

Exam context

This chapter explains the mathematical models that may be used to identify the lowest costs associated with holding inventory at given level of activity. It also explains other approaches that might be used in practice including just-in-time inventory management.

By the end of this chapter, you should be able to:

- Describe the economic order quantity (EOQ) and apply the concept in given scenarios
- Calculate the EOQ from data provided
- Describe safety stocks for inventories
- Explain the reasons for maintaining safety stock
- Calculate the safety stock using data provided
- Explain re-order levels and the objectives of setting re-order levels
- Calculate re-order levels using data provided

1 MATERIAL PURCHASE QUANTITIES: ECONOMIC ORDER QUANTITY

Section overview

- Costs associated with inventory
- Economic order quantity (EOQ)
- Optimum order quantity with price discounts for large orders

1.1 Costs associated with inventory

Many companies, particularly manufacturing and retailing companies, might hold large amounts of inventory. They usually hold inventory so that they can meet customer demand as soon as it arises. If there is no inventory when the customer asks for it (if there is a 'stock-out' or 'inventory-out') the customer might buy the product from a competitor instead. However holding inventory creates costs.

The costs associated with inventory are:

- Purchase price of the inventory;
- Re-order costs are the costs of making orders to purchase a quantity of a material item from a supplier. They include costs such as:
  - the cost of delivery of the purchased items, if these are paid for by the buyer;
  - the costs associated with placing an order, such as the costs of telephone calls;
  - costs associated with checking the inventory after delivery from the supplier;
  - batch set up costs if the inventory is produced internally.
- Inventory holding costs:
  - cost of capital tied up;
  - insurance costs;
  - cost of warehousing;
  - obsolescence, deterioration and theft.
- Shortage costs
  - lost profit on sale;
  - future loss of profit due to loss of customer goodwill;
  - costs due to production stoppage due to shortage of raw materials;

Investment in inventory has a cost. Capital is tied up in inventory and the capital investment has a cost. Inventory has to be paid for, and when an organisation holds a quantity of inventory it must therefore obtain finance to pay for it.

Example: Cost of holding inventory

A company holds between 0 units and 10,000 units of an item of material that costs ₦1,000 per unit to purchase.

The cost of the materials held in store therefore varies between ₦0 and ₦10,000,000.

If demand for the inventory is constant throughout the year the average cost of inventory held is ₦5,000,000 (half the maximum).

This inventory must be financed, and it is usual to assume (for simplicity) that it is financed by borrowing that has an interest cost.

If the interest cost of holding inventory is 5% per year, the cost per year of holding the inventory would be ₦250,000 (₦5,000,000 × 5%).

There are also running expenses incurred in holding inventory, such as the warehousing costs (warehouse rental, wages or salaries of warehouse staff).

A distinction can be made between variable inventory holding costs (cost of capital, cost of losses through deterioration and loss) and fixed inventory costs (wages and salaries, warehouse rental). Changing inventory levels will affect variable inventory holding costs but not fixed costs.

Trade off

Note that there is a trade-off between holding costs and ordering costs.

Example: Trade-off between holding costs and ordering costs

A company requires 12,000 of a certain component every year.

Demand for the component is constant. (This condition means that the average inventory is half of the maximum as long as there is no safety stock).

The company can decide on the number it orders and this affects the holding cost and ordering costs.

Let: Q = Order size
D = Annual demand

	Order size (Q)		
	12,000	6,000	3,000
Average inventory ($^Q/_2$)	6,000	3,000	1,500
Number of orders ($^D/_Q$)	1	2	3

The average inventory falls as the order size falls thus reducing holding cost. However, smaller orders mean more of them. This increases the order cost.

A business will be concerned with minimising costs and will make decisions based on this objective. Note that any decision making model must focus on those costs that are relevant to the decision. The relevant costs are only those that change with a decision. When choosing between two courses of action, say

A and B, any cost that will be incurred whether action A or action B is undertaken can be ignored. This is covered in more detail in chapter 14.

1.2 Economic order quantity (EOQ)

The Economic Order Quantity model (EOQ) is a mathematical model used to calculate the quantity of inventory to order from a supplier each time that an order is made. The aim of the model is to identify the order quantity for any item of inventory that minimises total annual inventory costs.

The model is based on simplifying assumptions.

Assumption	Implication
There are no bulk purchase discounts for making orders in large sizes. All units purchased for each item of material cost the same unit price.	Order size (Q) does not affect the total annual purchase cost of the items. Purchase price can be ignored in the decision as it does not affect the outcome.
The order lead time (the time between placing an order and receiving delivery from the supplier) is constant and known.	Delivery of a new order is always timed to coincide with running out of inventory so the maximum inventory is the order size (Q) There is no risk of being out of stock. Shortage costs can be ignored.
Annual demand for the inventory item is constant throughout the year.	Average inventory is the $^{\text{order size}}/_{2}$ because the maximum inventory is Q

As a result of the simplifying assumptions the relevant costs are the annual holding cost per item per annum and the annual ordering costs.

If the price of materials is the same, no matter what the size of the purchase order, the purchase order quantity that minimises total costs is the quantity at which ordering costs plus the costs of holding inventory are minimised.

The EOQ model formula

The order quantity or purchase quantity that minimises the total annual cost of ordering the item plus holding it in store is called the economic order quantity or EOQ.

Formula: Economic order quantity (Q)

$$Q = \sqrt{\frac{2C_O D}{C_H}}$$

Where:

Q = Quantity purchased in each order to minimise costs

C_O = Fixed cost per order

C_H = the cost of holding one item of inventory per annum

D = Annual demand

Notes:

There will be an immediate supply of new materials (Q units) as soon as existing quantities in store run down to zero. The minimum quantity held in store is therefore zero units and this always occurs just before a new purchase order quantity is received.

The maximum quantity held is Q units. The average amount of inventory held is therefore $^{Q}/_{2}$ and total holding costs each year are $(^{Q}/_{2}) \times C_H$.

The number of orders each year is $^{D}/_{Q}$. Total ordering costs each year are therefore $(^{D}/_{Q}) \times C_O$.

The economic order quantity (EOQ) is the order size that minimises the sum of these costs during a period (normally one year), given the assumptions stated above.

Example: Economic order quantity

A company uses 120,000 units of Material X each year, which costs ₦300 for each unit. The cost of placing an order is ₦6,500 for each order. The annual cost of holding inventory each year is 10% of the purchase price of a unit.

The economic order quantity for Material X is as follows:

C_O = Fixed cost per order = ₦6,500

C_H = the cost of holding one item of inventory per annum = 10% × 300= ₦30

D = Annual demand = 120,000 units

$$Q = \sqrt{\frac{2C_OD}{C_H}} = \sqrt{\frac{2 \times 6{,}500 \times 120{,}000}{30}} = 7{,}211.1$$

The EOQ is the quantity that minimises the sum of the annual order costs and the annual holding costs. The annual holding costs equal the annual order costs at this level.

Example: Annual costs of the EOQ

Using information from the previous example

Annual order costs:	₦
Number of orders × fixed cost per order	
$^{D}/_{Q} \times C_O = {}^{120,000}/_{7211.1} \times 6{,}500$	108,166
Annual holding costs:	
Average inventory × cost of holding one item per annum:	
$^{Q}/_{2} \times 30 = {}^{7,211.1}/_{2} \times 30$	108,166
Total annual cost that is minimised by the EOQ	**216,332**
Annual purchase price (D × Price = 120,000 × 300)	36,000,000
Total annual cost	36,216,332

The costs that are minimised are often very small compared to the purchase price in the model. The purchase price is irrelevant in deciding the order quantity because it is not affected by the order size when the annual demand is constant.

Total annual ordering costs and annual holding costs are always the same whenever the purchase quantity for materials is the EOQ and the assumptions on which the EOQ is based (described earlier) apply. This would not be the case if safety inventory was held (but the simplifying assumptions preclude this from happening).

Practice questions **1**

1 A company uses the economic order quantity (EOQ) model to determine the purchase order quantities for materials.

The demand for material item M234 is 12,000 units every three months.

The item costs ₦80 per unit, and the annual holding cost is 6% of the purchase cost per year. The cost of placing an order for the item is ₦250.

What is the economic order quantity for material item M234 (to the nearest unit)?

2 A company uses the economic order quantity (EOQ) model to determine the purchase order quantities for materials.

The demand for material item M456 is 135,000 units per year. The item costs ₦100 per unit, and the annual holding cost is 5% of the purchase cost per year.

The cost of placing an order for the item is ₦240.

What are the annual holding costs for material item M456?

3 A company uses a chemical compound, XYZ in its production processes.

XYZ costs ₦1,120 per kg. Each month, the company uses 5,000 kg of XYZ and holding costs per kg. per annum are ₦20.

Every time the company places an order for XYZ it incurs administrative costs of ₦180.

What is the economic order quantity for material item XYZ (to the nearest unit)?

1.3 Optimum order quantity with price discounts for large orders

When the EOQ formula is used to calculate the purchase quantity, it is assumed that the purchase cost per unit of material is a constant amount, regardless of the order quantity.

If a supplier offers a discount on the purchase price for orders above a certain quantity the purchase price becomes a relevant cost. When this situation arises, the order quantity that minimises total costs will be either:

- The economic order quantity; or
- The minimum order quantity necessary to obtain the price discount.

The total costs each year including purchases, ordering costs and holding costs, must be calculated for the EOQ and the minimum order quantity to obtain each discount on offer.

Example: Optimum order quantity with price discounts

A company uses 120,000 units of Material X each year, which costs ₦300 for each unit.

The cost of placing an order is ₦6,500 for each order.

The annual cost of holding inventory each year is 10% of the purchase cost.

The EOQ based on the above information is 7,211 units.

The supplier offers a price discount of ₦5 per unit for orders of 10,000 or more.

The order quantity that will minimise total costs is found as follows:

Order quantity:	**7,211.1 units**	**10,000 units**
	₦	₦
Annual ordering costs (		
$^{D}/_{Q} \times C_O = {}^{120,000}/_{7211.1} \times 6,500$	108,166	
$^{D}/_{Q} \times C_O = {}^{120,000}/_{10,000} \times 6,500$		78,000
Holding costs		
$^{Q}/_{2} \times 30 = {}^{7,211.1}/_{2} \times 30$	108,166	
$^{Q}/_{2} \times 30 = {}^{10,000}/_{2} \times 30$		150,000
	216,332	228,000
Annual purchase costs		
120,000 × ₦300	36,000,000	
120,000 × ₦(300 – 5)		35,400,000
Total costs	36,216,332	35,628,000

Conclusion: The order quantity that minimises total costs is 10,000 units.

(The sum of the annual ordering costs plus the annual holding costs is greater for 10,000 units as would be expected from our knowledge of the EOQ model. However this increase is more than compensated for by the saving in purchase price at this order level.)

Practice question **2**

A company uses 120,000 units of Material X each year, which costs ₦3 for each unit before discount.

The costs of making an order are ₦605 for each order. The annual cost of holding inventory is 10% of the purchase cost.

The supplier offers a price discount of ₦0.10 per unit for orders of 25,000 up to 40,000 units, and a discount of ₦0.20 per unit for orders of 40,000 units or more.

Find the quantity that will minimise total costs.

2 RE-ORDER LEVEL AND BUFFER STOCK

Section overview

- Inventory re-order level and other warning levels
- Re-order level avoiding stock-outs and buffer stock
- Maximum inventory level
- Minimum inventory level
- Using a probability table to decide the optimal re-order level

2.1 Inventory reorder level and other warning levels

So far, it has been assumed that when an item of materials is purchased from a supplier, the delivery from the supplier will happen immediately. In practice, however, there is likely to be some uncertainty about when to make a new order for inventory in order to avoid the risk of running out of inventory before the new order arrives from the supplier. There are two reasons for this:

- There is a supply lead time. This is the period of time between placing a new order with a supplier and receiving the delivery of the purchased items. The length of this supply lead time might be uncertain and might be several days, weeks or even months.
- The daily or weekly usage of the material might not be a constant amount. During the supply lead time, the actual usage of the material may be more than or less than the average usage.

If demand for an inventory item exceeds the available quantity of inventory during the reorder period, there will be a stock-out (inventory-out). When there is a stock-out of a key item of inventory used in production, there would be a hold-up in production and a disruption to the production schedules. This in turn may lead to a loss of sales and profits. Stock-outs therefore have a cost.

Management responsible for inventory control might like to know:

- What the reorder level should be for each item of materials, in order to avoid any stock-out. (reorder level is the level of inventory at which a new order for the item should be placed with the supplier);
- Whether the inventory level for each item of material appears to be too high or too low;
- What the reorder level should be for each item of materials, if stock-outs can be allowed to happen.

In an inventory control system, if there is uncertainty about the length of the supply lead time and demand during the lead time there might be three warning levels for inventory, to warn management that:

- The item should now be reordered (the reorder level)
- The inventory level is too high (a maximum inventory level) or
- The inventory level is getting dangerously low (a minimum inventory level).

2.2 Re-order level avoiding stock-outs and buffer stock

If the management policy is to avoid stock-outs entirely, the reorder level should be high enough to ensure that no stock-out occurs during the supply lead time. A new quantity of materials should be ordered when current inventory reaches the reorder level for that material.

If the supply lead time (time between placing an order and receiving delivery) is certain and demand during the lead time is constant a company would be able to set a reorder level such that it used the last item just as a new order arrived, thus reducing holding costs to a minimum.

The reorder level to do this is found as follows.

Illustration: Re-order level – Certain lead time and constant demand

Demand for the material item per day/week × Lead time in days/weeks

If the supply lead time is uncertain, and demand during the lead time is also uncertain, there should be a safety level of inventory. A company may wish to ensure that they are never out of stock. The reorder level to achieve this is found as follows.

Illustration: Re-order level: Uncertain demand in lead time

Maximum demand for the material item per day/week	×	Maximum supply lead time in days/weeks

Safety inventory ('buffer stock' or 'safety stock')

The re-order level is therefore set at the maximum expected consumption of the material item during the supply lead time. This is more than the average usage during the supply lead time. As a result more inventory is held that is needed on average.

Illustration: Average inventory

$$^{Q}/_{2} + \text{Safety inventory}$$

Safety inventory is the average amount of inventory held in excess of average requirements in order to remove the risk of a stock-out. The size of the safety inventory is calculated as follows:

Illustration: Safety inventory (also known as buffer stock)

	Units
Reorder level:	
Maximum demand per day × Maximum lead time	X
Average usage in the lead time period:	
Average demand per day × Average lead time	(X)
Safety inventory	X

The cost of holding safety inventory is the size of the safety inventory multiplied by the holding cost per unit per annum.

2.3 Maximum inventory level

A company will set a maximum level for inventory. Inventory held above this would incur extra holding cost without adding any benefit to the company.

The inventory level should never exceed a maximum level. If it does, something unusual has happened to either the supply lead time or demand during the supply lead time. The company would investigate this and take action perhaps adjusting purchasing behaviour.

When demand during the supply lead time is uncertain and the supply lead time is also uncertain, the maximum inventory level is found as follows.

Illustration: Maximum inventory level

			Units
Reorder level			X
Reorder quantity			X
			X
Less:			
Minimum demand per day/week	×	Minimum supply lead time in days/weeks	(X)
			X

This maximum level should occur at the time that a new delivery of the item has been received from the supplier. The supply lead time is short; therefore there are still some units of inventory when the new delivery is received.

2.4 Minimum inventory level

The inventory level could be dangerously low if it falls below a minimum warning level. When inventory falls below this amount, management should check that a new supply will be delivered before all the inventory is used up, so that there will be no stock-out.

When demand during the supply lead time is uncertain and the supply lead time is also uncertain, the minimum (warning) level for inventory is set as follows.

Illustration: Minimum inventory level

			Units
Reorder level			X
Less:			
Average demand per day/week	×	Average lead time in days/weeks	(X)
			X

Example: Re-order levels and buffer stock

A company uses material item BC67. The reorder quantity for this material is 12,000 units. There is some uncertainty about the length of the lead time between ordering more materials and receiving delivery from the supplier. There is also some variability in weekly demand for the item.

	Supply lead time (weeks)
Average	2.5
Maximum	3
Minimum	1

	Demand per week (units)
Average	1,200
Maximum	1,500
Minimum	800

Re-order level

Maximum demand for the material item per day	×	Maximum lead time in days/weeks	=	Reorder level
1,500 units	×	3 weeks	=	**4,500 units**

Buffer stock (safety inventory)		**Units**
Re-order level		4,500
Average demand per week	1,200 units	
Average lead time (weeks)	× 2.5 weeks	
Subtract:		(3,000)
		1,500

Maximum inventory level		**Units**
Re-order level		4,500
Reorder quantity		12,000
Minimum demand per week	800 units	
Minimum lead time (weeks)	× 1 week	
		(800)
		15,700

Minimum inventory level		**Units**
Re-order level		4,500
Average demand per week	1,200 units	
Average lead time (weeks)	× 2.5 weeks	
Subtract:		(3,000)
		1,500

The minimum inventory level is the buffer stock quantity.

A question might combine the EOQ model and reorder level or safety inventory (buffer stock).

Example: EOQ model and re-order level

A company orders 50,000 units of an item when the inventory level falls to 100,000 units.

Annual consumption of the item is 1,800,000 units per year.

The holding cost per unit is ₦1.50 per unit per year and the cost of making an order for delivery of the item is ₦375 per order.

The supply lead time is 2 weeks (assume a 50-week year and constant weekly demand for the item).

Required

Calculate the cost of the current ordering policy and calculate how much annual savings could be obtained using the EOQ model if the existing policy on buffer stack was retained.

Answer

Step 1: Calculate the safety inventory

Weekly demand = $^{1,800,000}/_{50\text{ weeks}}$ = 36,000 units.

Safety inventory = 100,000 units – (36,000 units × 2 weeks) = 28,000 units.

Average inventory = $^{50,000\text{ units}}/_{2}$ + Safety inventory = 25,000 + 28,000 = 53,000 units.

Step 2: Work out the annual costs of the current policy

Annual cost of current policy	**₦**
Order costs: ₦375 × ($^{1,800,000}/_{50,000}$)	13,500
Holding costs of order quantity: ($^{50,000\text{ units}}/_{2}$) × ₦1.50	37,500
Holding costs of safety inventory: 28,000 × ₦1.50	42,000
Holding costs of average inventory: 53,000 × ₦1.50	79,500
	93,000

Step 3: work out the annual costs associated with the EOQ

$$\text{EOQ} = \sqrt{\left(\frac{2 \times 1{,}800{,}000 \times 375}{1.5}\right)} = \sqrt{900{,}000{,}000} = 30{,}000 \text{ units}$$

Average inventory = $^{30,000\text{ units}}/_{2}$ + Safety inventory = 15,000 + 28,000 = 43,000 units.

Annual cost of EOQ policy	**₦**
Order costs: ₦375 × ($^{1,800,000}/_{30,000}$)	22,500
Holding costs of EOQ : ($^{30,000}/_{2}$) × ₦1.50	22,500
Holding cost of safety inventory: 28,000 × ₦1.50	42,000
Holding costs of new average inventory: 43,000 × ₦1.50	
	87,000
Cost of current policy	93,000
Annual saving by ordering EOQ	6,000

2.5 Using a probability table to decide the optimal re-order level

When a company is prepared to accept the risk of stock-outs, the optimal reorder level might be estimated using probabilities of demand (and probabilities of the supply lead time) to calculate the reorder level that has the lowest expected value of total cost.

A probability table can be prepared. For each possible reorder level under consideration, we can calculate:

- The probable demand in the lead time between order and delivery;
- The risk of having excess inventory (buffer stock) and its cost;
- The risk of stock-outs, and their cost.

The reorder level selected might be the reorder level at which the expected value (EV) of cost is minimised.

Example: Re-order level and probabilities

Entity X uses item Z in its production process. It purchases item Z from an external supplier, in batches.

For item Z, the following information is relevant:

Holding cost	₦15 per unit per year
Stock out cost	₦5 for each stock-out
Lead-time	1 week
EOQ	270 units

Entity X operates for 48 weeks each year. Weekly demand for unit Z for production is variable, as follows:

Units demanded during the lead time	Probability
70	10%
80	20%
90	30%
100	40%

Required

Suggest whether a re-order level of 90 units or 100 units would be more appropriate.

Answer

Step 1: Calculate the average demand in the lead time

The average demand in the lead-time is:

(70 × 10%) + (80 × 20%) + (90 × 30%) + (100 × 40%) = 90 units

Average annual demand is 48 weeks × 90 units = 4,320 units.

Since the EOQ is 270 units, entity X will expect to place $\frac{4,320}{270}$ orders = 16 orders each year. Therefore there will be 16 lead times each year.

Step 2: Set up a probability table

(Starting with a reorder level is set to the average demand in the lead time and then looking at higher reorder levels).

Re-order level of 90 (the company will be out of stock if demand is greater than 90)

Demand = 100

Stock outs if demand is 100	10 units
Probability of demand of 100	× 0.4
Cost per stock out	× ₦5
Number of orders per year	× 16
Annual stock out cost	320
Buffer stock (reorder level – average demand in lead time)	nil
	320

Re-order level of 100 (the company will never be out of stock)

Stock out cost	nil
Buffer stock (reorder level – average demand in lead time)	10 units
Holding cost per unit per annum	× ₦15
	₦150

The re-order level should be set at 100 units. The extra cost of the buffer stock (₦150) achieves savings by reducing the stock out cost (₦320).

Notice the trade off, in the above example, between the cost of stock out and the holding costs at different reorder levels. A higher re-order level reduces the chance of a stock out but incurs higher holding costs.

3 JUST-IN-TIME (JIT) AND OTHER INVENTORY MANAGEMENT METHODS

Section overview

- JIT production and JIT purchasing
- Practical implications of JIT
- Other inventory control systems
- ABC method of inventory control

3.1 JIT production and JIT purchasing

Just-in-Time (JIT) management methods originated in Japan in the 1970s. JIT is a radically different approach to inventory management compared with management using the EOQ model and reorder levels.

The principle of JIT is that producing items for inventory is wasteful, because inventory adds no value, and holding inventory is therefore an expense for which there is no benefit.

If there is no immediate demand for output from any part of the system, a production system should not produce finished goods output for holding as inventory. There is no value in achieving higher volumes of output if the extra output goes into inventory as it has no immediate use.

Similarly, if there is no immediate demand for raw materials, there should not be any of the raw materials in inventory. Raw materials should be obtained only when they are actually needed.

It follows that in an ideal production system:

- There should be no inventory of finished goods: items should be produced just in time to meet customer orders, and not before (just in time production); and
- There should be no inventories of purchased materials and components: purchases should be delivered by external suppliers just in time for when they are needed in production (just in time purchasing).

3.2 Practical implications of JIT

JIT production

It is important that items should be available when required. Finished goods must be available when customers order them, and raw materials and components must be supplied when they are needed for production.

In practice, this means that:

- Production times must be very fast. If there is no inventory of finished goods, production has to be fast in order to meet new customer orders quickly.
- Production must be reliable, and there must be no hold-ups, stoppages or bottlenecks. Poor quality production, leading to rejected items and scrap, is unacceptable.

- Deliveries from suppliers must be reliable: suppliers must deliver quickly and purchased materials and components must be of a high quality (so that there will be no scrapped items or rejected items in production).

JIT purchasing

JIT depends for its success not only on highly efficient and high-quality production, but also on efficient and reliable supply arrangements with key suppliers. For successful JIT purchasing, there must be an excellent relationship with key suppliers. Collaborative long-term relationships should be established with major suppliers, and purchasing should not be based on selecting the lowest price offered by competing suppliers.

By implementing a JIT system, an entity will be working with its key ('strategic') suppliers to implement a manufacturing system that will:

- Reduce or eliminate inventories and WIP;
- Reduce order sizes, since output is produced to meet specific demand and raw material deliveries should be timed to coincide with production requirements; and
- Ensure deliveries arrive in the factory exactly at the time that they are needed.

The overall emphasis of a JIT purchasing policy is on consistency and quality, rather than looking for the lowest purchase price available.

Problems with JIT

There might be several problems with using JIT in practice.

- Zero inventories cannot be achieved in some industries, where customer demand cannot be predicted with certainty and the production cycle is quite long. In these situations, it is necessary to hold some inventories of finished goods.
- It might be difficult to arrange a reliable supply system with key suppliers, whereby suppliers are able to deliver materials exactly at the time required.
- If the EOQ model succeeds in minimising total costs of holding costs and ordering costs, this suggests that with a JIT purchasing system, ordering costs might be very high.

3.3 Other inventory control systems

EOQ and JIT are two methods of managing and controlling inventory and purchasing quantities. Other systems might be used.

Two bin system

When a two-bin system is used in a warehouse or stores department, each item of inventory is stored in two bins or large containers. Inventory is taken from Bin 1 until it is empty, and a new order is placed sufficient to fill Bin 1 again.

However, the delivery of more units of the item will take time, and since Bin 1 is empty, units are now taken from Bin 2. Bin 2 is large enough to continue supplying the item until the new delivery arrives. On delivery both bins are replenished and units are once again supplied from Bin 1.

This cycle continues indefinitely.

Periodic review system

In a periodic review system, there is a reorder quantity and a reorder level for each item of inventory.

Inventory levels are checked periodically, say every one, two, three or four weeks. If the inventory level for any item has fallen below its reorder level, a new order for the reorder quantity is placed immediately.

Example:

The demand for an inventory item each week is 400 units, and inventory control is applied by means of a three-weekly periodic review. The lead-time for a new order is two weeks.

The minimum inventory level should therefore be (3 weeks + 2 weeks) = 5 weeks × 400 units = 2,000 units.

If the inventory level is found to be lower than this level at any periodic review, a new order for the item should be made.

3.4 ABC method of inventory control

With the ABC method of inventory control, it is recognised that some items of inventory cost much more than others to hold. Inventory can perhaps be divided into three broad categories:

- Category A inventory items, for which inventory holding costs are high.
- Category B inventory items, for which inventory holding costs are fairly high, but not as high as for category A items.
- Category C inventory items, for which inventory holding costs are low and insignificant. Holding excessive amounts of these inventory items would not affect costs significantly.

The ABC approach to inventory control is to control each category of inventory differently, and apply the closest control to those items in the most costly category, A. For example:

- Category A items might be controlled by purchasing the EOQ as soon as the inventory level falls to a set reorder level.
- Category B items might be controlled by a periodic review system, with orders placed to restore the inventory level to a maximum level.
- Category C items might be purchased in large quantities, and controlled by means of a two-bin system.

Identifying categories

A company operating this system would introduce a policy to identify which inventory lines are in which category.

The policy would be based on the value of inventory used in the year.

Example: ABC system of inventory control

A company operates the ABC system of inventory control.

Category A: The fewest Items which account for at least 50% of the company's annual expenditure on inventory.

Category B: Items accounting from the end of items identified as A up to an including 80% annual expenditure on inventory.

Category C: All other items.

The following information has been identified in respect of the company's inventory line in a year.

Inventory line	Cost per item	Annual usage (units)
101	50	100
102	360	50
103	30	120
104	90	50
105	30	100
106	25	180
107	15	165
108	150	50
109	400	75
110	20	120

Example: ABC system of inventory control

Step 1: Identify the total amount spent on each inventory line by multiplying the cost per item by the number of items used.

Inventory line	Cost per item	Annual usage (units)	Total amount spent
101	50	100	5,000
102	360	50	18,000
103	30	120	3,600
104	90	50	4,500
105	30	100	3,000
106	25	180	4,500
107	15	165	2,475
108	150	50	7,500
109	400	75	30,000
110	20	120	2,400

Example: ABC system of inventory control

Step 3: Rank the items by total spend (highest first) and sum the total spend column.

(You must always estimate the total spend and then rank the items in order to identify the high value items).

Stock line	Cost per item	Annual usage (units)	Total amount spent
109	400	75	30,000
102	360	50	18,000
108	150	50	7,500
101	50	100	5,000
104	90	50	4,500
106	25	180	4,500
103	30	120	3,600
105	30	100	3,000
107	15	165	2,475
110	20	120	2,400
			80,975

Example: ABC system of inventory control

Step 4: Express each individual total spend figure as a percentage of the total spend on all stock lines and construct a cumulative percentage column.

For example: Total spend on line 109 is 37% of the total ($^{30,000}/_{80,975}$)

Stock line	Cost per item	Annual usage (units)	Total amount spent	Annual value as a % of total	Cumulative %
109	400	75	30,000	37.0%	37.0%
102	360	50	18,000	22.2%	59.3%
108	150	50	7,500	9.3%	68.5%
101	50	100	5,000	6.2%	74.7%
104	90	50	4,500	5.6%	80.3%
106	25	180	4,500	5.6%	85.8%
103	30	120	3,600	4.4%	90.3%
105	30	100	3,000	3.7%	94.0%
107	15	165	2,475	3.1%	97.0%
110	20	120	2,400	3.0%	100.0%
			80,975		

Example: ABC system of inventory control

Step 5: Identify categories based on the stated policy.

Stock line	Cumulative %	Category	
109	37.0%	A	The fewest Items which account for at least 50% of the company's annual expenditure
102	59.3%	A	
108	68.5%	B	Items accounting from the end of items identified as A up to an including 80% annual expenditure on inventory.
101	74.7%	B	
104	80.3%	B	
106	85.8%	C	Other items
103	90.3%	C	
105	94.0%	C	
107	97.0%	C	
110	100.0%	C	

In the above examples the categories have been identified by applying percentages to total. This could also be done using annual usage of items.

Example: ABC system of inventory control

The company might want to identify the categories using annual usage. In this case the items are ranked as before but selected based on percentage usage.

Percentage columns are built for usage instead of for total spend.

Using the previous example the company now wishes to identify categories as follows:

Category A: The fewest Items which account for at least 30% of the company's annual usage on inventory.

Category B: Items accounting from the end of items identified as A up to an including 75% annual usage on inventory.

Category C: All other items.

The analysis would be completed as follows:

Stock line	Cost per item	Annual usage (units)	Total amount spent	Annual usage as a % of total	Cumulative %
109	400	75	30,000	7.4%	7.4%
102	360	50	18,000	5.0%	12.4%
108	150	50	7,500	5.0%	17.3%
101	50	100	5,000	9.9%	27.2%
104	90	50	4,500	5.0%	32.2%
106	25	180	4,500	17.8%	50.0%
103	30	120	3,600	11.9%	61.9%
105	30	100	3,000	9.9%	71.8%
107	15	165	2,475	16.3%	88.1%
110	20	120	2,400	11.9%	100.0%
		1,010			

Example: ABC system of inventory control

Identify categories based on the stated policy.

Stock line	Cumulative %	Category
109	7.4%	A
102	12.4%	A
108	17.3%	A
101	27.2%	A
104	32.2%	A
106	50.0%	B
103	61.9%	B
105	71.8%	B
107	88.1%	C
110	100.0%	C

The fewest Items which account for at least 30% of the company's annual usage on inventory

Items accounting from the end of items identified as A up to an including 75% annual usage on inventory

4 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Describe the economic order quantity (EOQ) and apply the concept in given scenarios
- Calculate the EOQ from data provided
- Describe safety stocks for inventories
- Explain the reasons for maintaining safety stock
- Calculate the safety stock using data provided
- Explain re-order levels and the objectives of setting re-order levels
- Calculate re-order levels using data provided

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

1 Economic order quantity

$$Q = \sqrt{\frac{2C_0D}{C_H}} = \sqrt{\frac{2 \times 250 \times (4 \times 12{,}000)}{6\% \times 80}} = 2{,}236 \text{ units}$$

2 Economic order quantity

$$Q = \sqrt{\frac{2C_0D}{C_H}} = \sqrt{\frac{2 \times 240 \times 135{,}000}{5\% \times 100}} = 3{,}600 \text{ units}$$

Annual holding cost

$$\frac{Q}{2} \times C_H = \frac{3{,}600}{2} \times 5 = ₦9{,}000$$

3 Economic order quantity

$$Q = \sqrt{\frac{2C_0D}{C_H}} = \sqrt{\frac{2 \times 180 \times (5{,}000 \times 12)}{20}} = 1{,}039 \text{ units}$$

Solutions **2**

EOQ

$$EOQ = \sqrt{\frac{2C_0D}{C_H}}$$

Where:

CO = 605

D = 120,000

CH = 10% × 3 = 0.3

$$= \sqrt{\left(\frac{2 \times 120{,}000 \times 605}{0.3}\right)} = \sqrt{484{,}000{,}000} = 22{,}000 \text{ units}$$

The economic order quantity is 22,000 units

The order quantity that will minimise total costs is found as follows:

	Order quantity 22,000 units	25,000 Units	40,000 units
	₦	₦	₦
Annual purchase costs			
120,000 × ₦3	360,000		
120,000 × ₦(3 – 0.10)		348,000	
120,000 × ₦(3 – 0.20)			336,000
Annual ordering costs ($D/Q \times C_O$)			
(120,000/22,000) × ₦605	3,300		
(120,000/25,000) × ₦605		2,904	
(120,000/40,000) × ₦605			1,815
Holding costs ($Q/2 \times C_H$)			
(22,000/2) × ₦0.3	3,300		
(25,000/2) × ₦0.29		3,625	
(40,000/2) × ₦0.28			5,600
Total costs	366,600	354,529	343,415

Conclusion

The order quantity that minimises total costs is 40,000 units.

Skills level
Performance management

CHAPTER 23

Management of receivables and payables

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**			
	2	**Working capital management**		
		a	Discuss the nature, elements and importance of working capital.	
		c	Evaluate and discuss the use of relevant techniques in managing working capital in relation to:	
			ii	Account receivables (including cash discounts, factoring and invoice discounting); and
			iii	Account payables

Exam context

This chapter explains the management of payables and receivables.

By the end of this chapter, you should be able to:

- Explain the benefits and costs of giving credit
- Explain the components of a receivables management system
- Evaluate the impact of a change in working capital management policy
- Explain debt factoring
- Measure the cost of settlement discounts
- Understand trade payables as a source of short term finance

1 COSTS AND BENEFITS OF GIVING CREDIT

Section overview

- Benefits of giving credit
- Cost of giving credit

Business entities that sell to other businesses normally sell on agreed credit terms. Often 'standard' credit terms are applied for most business transactions, such as 30 days or 60 days from the date of the invoice. Most sales to consumers are for cash, but some businesses might even sell to consumers on credit.

It is generally assumed that if customers are allowed time to pay what they owe, they will take the full period of credit. For example, if a customer is allowed 30 days to pay an invoice, it is generally assumed that the customer will not pay until day 30.

1.1 Benefits of giving credit

By giving credit, sales volume will be higher. Higher sales volumes result in higher contribution, and higher profit.

If a business does not give credit to customers, customers are likely to buy from competitors who do offer credit.

1.2 Cost of giving credit

There are several costs of giving credit.

- **Finance costs**: There is a finance cost. Trade receivables must be financed. The longer the period of credit allowed to customers, the bigger the investment in working capital must be. The cost of investing in trade receivables is usually calculated as: Average trade receivables in the period × Cost of capital for the period
- **Bad debt costs**: Selling on credit creates a risk that the customer might never pay for the goods supplied. The cost of bad debts is usually measured as the amount of sales revenue due from the customers, that is written off as non-collectable.
- **Administration costs**: Additional administration costs might be incurred in negotiating credit terms with customers, and monitoring the credit position of customers. In dealing with problems about the cost of trade receivables, you should consider only the incremental administration costs incurred as a consequence of providing credit.

Example: Cost of giving credit

Nigerian Green Company currently offers customers 30 days' credit. Annual credit sales are ₦12 million, the contribution/sales ratio is 25% and bad debts are 1% of sales. The company has estimated that if it increased credit to 60 days, total annual sales would increase by 10%, but bad debts would rise to 1.5% of sales. The cost of capital for Green Company is 9%.

Assume that a year has 360 days.

Required

Estimate the effect on annual profit of increasing the credit period from 30 to 60 days.

Answer

Annual sales will increase from ₦12 million to ₦13.2 million.

		₦
Current average receivables	30/360 × ₦12 million	1,000,000
Average receivables with credit of 60 days	60/360 × ₦13.2 million	2,200,000
Increase in average receivables		1,200,000

Annual interest cost of increase in trade receivables = ₦1,200,000 × 9% = ₦108,000.

	₦	₦
Annual contribution with credit 30 days		3,000,000
Annual contribution with credit 60 days		3,300,000
Increase in annual contribution		300,000
Bad debts with credit 30 days (1% × ₦12 million)	120,000	
Bad debts with credit 60 days (1.5% × ₦13.2 million)	198,000	
Increase in bad debts	78,000	
Annual interest cost of extra receivables	108,000	
Total extra cost of longer credit		186,000
Net annual gain from increasing credit to 60 days		114,000

2 THE MANAGEMENT OF TRADE RECEIVABLES

Section overview

- Giving credit
- Monitoring payments
- Efficient collection of debts
- Bad debts and reducing bad debts

Giving credit to customers results in higher costs, in particular higher interest costs and some bad debts. These costs must be kept under control. To do this, trade receivables must be properly managed.

Good management of trade receivables involves systems for:

- Deciding whether to give customers credit, and how much credit to give them
- Monitoring payments
- Collecting overdue payments.

2.1 Giving credit

There should be procedures for deciding whether to give credit to a customer, and if so, how much. The procedures should differ between existing customers wanting extra credit, and new customers asking for credit for the first time. This is because existing customers already have a credit history. A company knows from experience whether an existing customer is likely to pay on time, or might have difficulty with payments.

When deciding whether or not to give extra credit to an existing customer, the decision can therefore be based largely on whether the customer has paid promptly in the past, and so whether on the basis of past performance the customer appears to be a good credit risk.

For new business customers, a variety of credit checks might be carried out.

- Asking for trade references from other suppliers to the customer who already give credit
- Asking for a reference from the customer's bank
- Making credit checks to discover whether any court judgements have been made against the customer for non-payment of debts
- Credit checks on small businesses can be purchased from credit reference agencies
- For business customers, asking for a copy of the most recent financial statements and carrying out a ratio analysis. Banks can usually persuade a business customer to provide a copy of its financial statements for decisions about granting a bank loan; but it is much more difficult for non-banks to do so, for decisions about giving trade credit
- Using reports from the company's salesmen. If a company sales representative has visited the business premises of the customer, a report about the apparent condition of the customer's business might be used to decide about whether or not to offer credit.

Usually, a company establishes credit policy guidelines that should be followed when giving credit to a new business customer. For example, a company might have a credit policy that for a new business customer, subject to a satisfactory credit check, it would be appropriate to offer credit for up to ₦2,000 for 30 days. This credit limit might then be reviewed after several months, if the customer pays invoices promptly within the credit terms.

The credit terms set for each customer will consist of:

- A **credit period**: The customer should be required to pay invoices within a stated number of days. Credit limits of 30 days or 60 days are common.
- A **credit limit**: This is the maximum amount of credit that the customer will be permitted. The limit is likely to be small at first for a new customer, increasing as the trading relationship develops.
- **Interest charges on overdue payments**: It might also be a condition of giving credit that the customer agrees to pay interest on any overdue payment. However, interest charges on late payments can create bad feeling, and customers who are charged interest might take their business to a rival supplier. Interest charges on late payments are therefore uncommon in practice.

(Note: Credit checks on individuals should be carried out by companies that give credit to customers, such as banks and credit card companies. Many companies, however, might give credit to corporate customers but ask for cash payment/credit card payment from individuals.)

2.2 Monitoring payments

A company should have a system for monitoring payments of invoices by customers. A regular report should be produced listing the unpaid debts, and which of these are overdue. This report might be called an ***aged debtors list***'or ***aged receivables list***.

A typical report might summarise the current position by showing how much money is owed by customers and for how long the money has been owed. A simple example of a summary is shown below.

Illustration: Aged receivables list

	Total	0 – 30 days	31 – 60 days	60 – 90 days	Over 90 days
	₦	₦	₦	₦	₦
Receivable	17,894,100	12,506,900	4,277,200	1,045,000	65,000

The report will also provide a detailed list of the unpaid invoices in each time period. By monitoring regular reports, the team responsible for collecting payments can decide which customers to 'chase' for payment and also to assess whether collections of receivables is under control. In the example above, if the company has normal credit terms of 30 days, it might be concerned that such a large amount of receivables – over ₦5 million, remain unpaid after 30 days.

2.3 Efficient collection of debts

When credit is given to customers, there should be efficient procedures for ensuring that customers pay on time, and that action is taken to obtain overdue payments.

Procedures for efficient debt collection include the following:

- Sending invoices to customers promptly, as soon as the goods or services have been provided.
- Sending regular statements to credit customers, showing how much they owe in total and how much is currently due for payment. Statements act as a reminder to customers to make a payment.
- Ensuring that credit terms are not exceeded, and the customer is not allowed to take longer credit or more credit than agreed.

Procedures for chasing overdue payments include:

- Telephone calls
- Reminder letters
- Taking a decision to withhold further supplies and further credit until an overdue debt is paid.

In extreme cases, measures might include:

- Using the services of a debt collection agency.
- Sending an official letter from a solicitor, threatening legal action.
- Legal action – obtaining a court judgement against the customer to force the customer to pay. This is a measure of last resort, to be taken only when there is a breakdown in the trading relationship.

2.4 Bad debts and reducing bad debts

When a company gives credit, there will be some bad debts. Bad debts are an expense in the income statement and have a direct impact on profitability. A company should try to minimise its bad debts, whilst accepting that even with efficient collection procedures some losses are unavoidable. For example some customers might become insolvent and go out of business still owing money.

There are several ways in which bad debts can be reduced:

- More extensive and careful credit checking procedures when deciding whether to give credit to customers
- More efficient collection procedures
- Reducing the amount of credit in total. As the total amount of credit given to customers increases, there will be an increase in the cost of bad debts, and the proportion of receivables that become bad debts. Reducing the total amount of credit will therefore reduce bad debts. However reducing the amount of credit to customers will probably result in lower sales revenue and lower gross profit.

Example: Bad debts

A company has annual sales of ₦20 million and all customers are given credit of 60 days. Gross profit on sales is 40%. Currently bad debts are 1.5% of sales. The cost of capital for the company is 10%.

Management is concerned about the high level of bad debts and they estimate that by reducing credit terms to 30 days for all customers, bad debts can be reduced to 0.5% of sales. However total sales revenue is likely to fall by 5% as a consequence of making the credit terms less generous.

Required

Calculate the estimated effect on annual profit of reducing the credit terms from 60 days to 30 days.

Answer

Current situation

Annual gross profit on current level of sales = 40% × ₦20 million = ₦8,000,000.

Current average trade receivables = (60/365) × ₦20 million = ₦3.29 million.

Current level of bad debts = 1.5% × ₦20 million = ₦300,000

	₦
Cost of investment in trade receivables (10% × ₦3.29 million)	329,000
Cost of bad debts	300,000
	629,000

Consequences of reducing credit to 30 days

Average trade receivables = (30/365) × 95% of ₦20 million = ₦1.56 million. Bad debts = 0.5% × 95% of ₦20 million = ₦95,000

	₦
Fall in gross profit (5% × ₦8,000,000)	400,000
Cost of investment in trade receivables (10% × ₦1.56 million)	156,000
Cost of bad debts	95,000
	651,000

The effect of offering stricter credit terms would be to reduce annual profit by ₦22,000 (651,000 – 629,000) due to the loss in sales and gross profit,which would occur.

3 DEBT FACTORS AND INVOICE DISCOUNTING

Section overview

- Debt factors and the services they provide
- The costs of factoring services
- Benefits and disadvantages of using a factor
- Evaluation of a factor's services
- Invoice discounting

3.1 Debt factors and the services they provide

Companies might use a factoring organisation to assist with the management of receivables and also to help with the financing of receivables.

Debt factors are specialist organisations. They specialise in:

- Assisting client firms to administer their trade receivables ledger;
- Providing short-term finance to client firms, secured by the trade receivables;
- In some cases, providing insurance against bad debts.

The services of a debt factor can be particularly useful for a small-to-medium-sized company that:

- Has a large number of credit customers;
- Does not have efficient debt collection procedures and therefore has a fairly high level of bad debts; and
- Does not have sufficient finance for its working capital.

A debt factor offers three main services to a client business:

- The administration of the client's trade receivables;
- Credit insurance; and
- Debt finance.

Trade receivables administration

A factor will take over the administration of trade receivables on behalf of a client. It sends out invoices on behalf of the client. Each invoice shows that the factor has issued the invoice, and the invoice asks for payment to be made to a bank account under the control of the factor. The factor collects the payments, and chases customers who are late with payment. The factor is also responsible for the client's trade receivables ledger, recording details of invoices and payments received in the ledger on behalf of the client.

The factor makes a charge for this service, typically an agreed percentage of the value of invoices sent out.

Credit insurance

If the factor is given the task of trade receivables administration, it may also agree (for an additional fee) to provide insurance against bad debts for the client. This is known as **without recourse factoring** or **non-recourse factoring**. If a customer of the client fails to pay an invoice that was issued by the factor, the factor will accept the bad debt loss itself, and the factor will pay the client the full amount of the unpaid invoice.

A factor will only provide without recourse factoring for invoices that are approved in advance by the factor. This is to prevent the client from giving credit to high-risk customers and exposing the factor to the risk of bad debts.

However, factors also provide **with recourse factoring**. With this type of arrangement, if a customer of the client fails to pay an invoice, the factor will not pay anything to the client, and the client must suffer the bad debt loss. (If the factor has already made a payment to the client against the security of the receivable, the client must repay the money it has received.)

Debt finance

The factor will provide advances of up to 80% of the face value of the client's trade receivables, for all receivables that are approved by the factor. The finance is provided at an agreed rate of interest, and is repayable when the customers' invoices are eventually paid. In effect, this means that when a customer pays the factor will remit the remaining 20% of the money to the client, less the interest (and other fees).

3.2 The costs of factoring services

The costs of a factoring service might therefore consist of:

- A service fee for the administration and collection of trade receivables;
- A commission charge, based on the total amount of trade receivables, for a non-recourse factoring service; and
- Interest charges for finance advanced against the trade receivables.

3.3 Benefits and disadvantages of using a factor

The benefits of using a factor are as follows:

- There should be savings in internal administration costs, because the factor administers the trade receivables ledger.
- With non-recourse factoring, there is a reduction in the cost of bad debts.
- A factor is a source of finance for trade receivables.

The disadvantages of using a factor are as follows.

- Interest charges on factor finance are likely to be higher than other sources of finance.
- Effect on customer goodwill. The factor is unlikely to treat the client's customers with the same degree of care and consideration that the client's own sales ledger administration team would.
- The client's reputation may be affected by the need to use a factor. Customers might believe that using a factor is a sign of financial weakness.

3.4 Evaluation of a factor's services

To assess the cost of using the services of a factor, you need to compare the total costs of the alternative policies.

As indicated above, the costs you will probably need to consider are:

- Costs of receivables ledger administration
- Costs of bad debts
- Financing costs for trade receivables.

Example: Debt factoring

Nigeria Blue Company has annual credit sales of ₦1,000,000. Credit customers take 45 days to pay. Bad debts are 2% of sales. The company finances its trade receivables with a bank overdraft, on which interest is payable at an annual rate of 15%.

A factor has offered to take over administration of the receivables ledger and collections for a fee of 2.5% of the credit sales. This will be a non-recourse factoring service. It has also guaranteed to reduce the payment period to 30 days. It will provide finance for 80% of the trade receivables, at an interest cost of 8% per year.

Nigeria Blue Company estimates that by using the factor, it will save administration costs of ₦8,000 per year.

Required

What would be the effect on annual profits if Nigeria Blue Company decides to use the factor's services? (Assume a 365-day year).

Answer

		₦
Current average trade receivables	45/365 × ₦1 million	123,288
Average receivables with the factor	30/365 × ₦1 million	82,192

It is assumed that if the factor's services are used, 80% will be financed by the factor at 8% and the remaining 20% will be financed by bank overdraft at 15%.

Annual interest costs		₦
Current situation	₦123,288 × 15%	18,493
With the factor	(80% × ₦82,192 × 8%) + (20% × ₦82,192 × 15%)	(7,726)
Saving in annual interest costs		10,767

Summary of comparative costs	₦
Saving in annual interest costs	10,767
Annual saving in bad debts (2% of ₦1 million)	20,000
Annual saving in administration costs	8,000
	38,767
Annual costs of factor's services (2.5% of ₦1 million)	(25,000)
Net increase in profit by using the factor	13,767

3.5 Invoice discounting

Invoice discounting is similar to the provision of finance by a factor. A difference is that whereas a factor provides finance against the security of all approved invoices of the client, an invoice discounter might provide finance against only a small number of selected invoices.

Another difference between a debt factor and an invoice discounter is that the invoice discounter will **only** provide finance services. An invoice discounter will not administer the trade receivables ledger or provide protection against the risk of bad debt. The invoice to the customer is sent out by the client firm, and payment is collected by the client firm (and paid into a special bank account set up for the purpose).

Example: Invoice discounting

A company might need to arrange finance for an invoice for ₦3 million to a customer, for which the agreed credit period is 90 days. An invoice discounter might be prepared to finance 80% of the invoiced amount, at an interest rate of 10%.

The company will issue the invoice to the customer for ₦3 million. The invoice discounter provides the company with a payment of ₦2.4 million (80% of ₦3 million).

After 90 days, the invoice discounter will expect repayment of the ₦2.4 million advance, plus interest of ₦59,178.

If the customer pays promptly, this repayment will be made out of the ₦3 million invoice payment by the customer. The invoice discounter will take ₦2,459,178 and the remaining ₦540,822 will go to the company.

4 SETTLEMENT DISCOUNTS

Section overview

- The nature and purpose of settlement discounts
- Evaluating a settlement discount

4.1 The nature and purpose of settlement discounts

The cost of financing trade receivables can be high. More important perhaps, if a company has a large investment in trade receivables, it might have cash flow problems and liquidity difficulties.

A company might therefore try to minimise its investment in trade receivables. One way of doing this is to ensure that collection procedures are efficient. Another policy for reducing trade receivables is to offer a discount for early payment of an invoice. This type of discount is called a settlement discount (or early settlement discount, or cash discount).

For example, a company might offer its customers normal credit terms of 60 days, but a discount of 2% for payment within ten days of the invoice date. If customers take the discount, there will be a reduction in average trade receivables.

4.2 Evaluating a settlement discount

The benefit of a settlement discount is that it reduces average trade receivables, and this reduces the annual interest cost of investing in trade receivables.

On the other hand, the discounts taken by customers reduce annual profit.

Evaluating a proposal to offer settlement discounts to customers therefore involves comparing the improvements in cash flow and reductions in interest cost with the cost of the discounts allowed.

The implied interest cost of settlement discounts

One way of evaluating a settlement discount is to calculate the implied interest cost of offering settlement discounts.

A formula for calculating the implied cost of offering a settlement discount is as follows:

Formula: Cost of a settlement discount

$$\left[1+\left(\frac{d}{(100-d)}\right)\right]^{\frac{365}{t}}-1$$

Where:

d = the size of the discount.

t = the difference in days between normal credit terms and the maximum credit period for taking advantage of the settlement discount.

Example: Cost of a settlement discount

For example, suppose that a company offers its customers normal credit terms of 60 days, but a discount of 2% for payment within ten days of the invoice date.

This discount policy implies that the company is prepared to accept ₦98 on day ten rather than accepting ₦100 on day 60. Financially, the company considers it beneficial to have ₦98 ‘now’ rather than ₦100 in 50 days’ time. This implies an average annual interest cost of:

$$\left[1+\left(\frac{2}{98}\right)\right]^{\frac{365}{(60-10)}}-1=0.1566 \text{ or } 15.66\%$$

If it costs the company less to borrow money to finance its trade receivables, it would be cheaper to offer credit of 60 days, and not to offer the discount of 2% for payment within ten days.

Practice question **1**

Entity X borrows on overdraft at an annual interest rate of 15%.

Customers are normally required to pay within 45 days. Entity X offers a 1.5% discount if payment is made within ten days.

What is the effective annual cost of offering the settlement discount, and is the discount policy financially justified?

Calculating the total annual costs

An alternative method of calculating the cost of settlement discounts, compared with a policy of not offering discounts, would be to compare the total annual costs with each policy.

Example:

Okongwo Nigeria Limited borrows on overdraft at an annual interest rate of 15%.

It has annual credit sales of ₦5 million, and all customers buy on credit. Customers are normally required to pay within 45 days. Okongwu Nigeria Limited offers a 1.5% discount if payment is made within ten days. 60% of customers take the discount.

What is the annual cost of the discount policy?

Answer

Cost of annual settlement discounts = ₦5 million × 60% × 1.5% = ₦45,000.

Average receivables without the discount policy

$$= \left(\frac{45}{365}\right) \times ₦5 \text{ million} = ₦616,438.$$

Average receivables with the discount policy:

		₦
Customers who will not take the discount	(45/365) × 40% × ₦5 million	246,575
Customers who will take the discount	(10/365) × 60% × ₦5 million	82,192
Total receivables with the discount policy		328,767

The net cost or benefit of the discount policy can be calculated as follows.:

		₦
Interest cost of receivables:		
Without discount policy	₦616,438 × 15%	92,466
With discount policy	₦328,767 × 15%	49,315
Interest saved with the discount policy		43,151
Cost of annual settlement discounts		45,000
Extra annual cost of discount policy		1,849

In this case, the settlement discount will be expected to reduce annual profit by about ₦1,800.

5 MANAGEMENT OF WORKING CAPITAL FOR FOREIGN TRADE

Section overview

- The additional problems with foreign trade
- Obtaining quicker payment
- Protection against credit risks
- Forward exchange contracts to hedge against foreign currency risk

5.1 The additional problems with foreign trade

When a business entity sells to customers in other countries, and the customer is in a country with a different currency, there are extra problems for working capital management, and risks for the business. The extra risks are:

- The **longer time period** between despatching goods to the customer and receiving payment. When goods are shipped to another country, it could take several weeks before the customer receives the goods. Foreign customers are usually unwilling to pay for goods until they are certain of receipt.

  If a longer payment period is allowed for foreign customers, the investment in trade receivables will be larger than if normal credit is allowed, and the interest cost will therefore be higher.

- There is a **greater risk of bad debt**. If a foreign customer does not pay, it will be more difficult and expensive to take action to collect the debt. For example, the company might have no understanding of the legal procedures for collecting unpaid debts in other countries.

- **Foreign currency risks**. If a company invoices its foreign customers in a foreign currency, there will be a foreign exchange risk. This is the risk that the value of the foreign currency will deteriorate between the time of issuing the invoice to the customer and the time of receiving payment. A movement in foreign exchange rates could even wipe out the expected profit on a foreign sale.

5.2 Obtaining quicker payment

In many cases, a company that sells to foreign customers must accept that it will have to wait longer for payment. A large investment in foreign trade receivables could therefore be unavoidable, and the interest cost has to be accepted.

However, in some cases it might be possible to arrange quicker payment. One method of both reducing the bad debt risk and obtaining quicker payment is to arrange an export sale using a **letter of credit**.

A letter of credit is an arrangement in which the exporter undertakes to provide the foreign buyer with specific documents that provide evidence that the goods have been shipped. The required documents normally include suitable shipping and insurance documents, and an invoice.

If the exporter delivers the specified documents to a bank representing the foreign buyer, the buyer agrees to make the payment. Payment is usually arranged by means of a bank bill of exchange. A bank representing the foreign buyer undertakes to pay a bill of exchange, for the amount of the invoice at a future date (the end of the credit period for the foreign buyer). Since the bank is undertaking to pay the bill of exchange, the exporter's credit risk is not the foreign buyer, but the bank. The credit risk should therefore be low.

If the exporter wants quicker payment, it can arrange with its own bank for the bill of exchange to be sold in the discount market. Bills are sold in the discount market for less than their face value; therefore by selling a bank bill to get quicker payment, the exporter incurs a cost. (When the bank bill reaches maturity, the bank will make its payment to the holder of the bill. The bank will recover the money from its client, the foreign buyer).

Letters of credit are fairly expensive to arrange, but they offer the benefits to an exporter of:

- Lower credit risk; and
- If required, earlier payment (minus the discount on the bank bill when it is sold).

5.3 Protection against credit risks

As indicated above, the credit risk in foreign trade can be reduced by arranging an irrevocable letter of credit.

Another method of reducing the credit risk might be to buy **credit risk insurance**.

Credit insurance is available from specialist organisations, and also possibly from some banks/insurance companies.

5.4 Forward exchange contracts to hedge against foreign currency risk

There is a risk that if a sale to a foreign buyer is priced in a foreign currency, the value of the foreign currency could depreciate in the time between selling the goods and eventually receiving payment.

Example: Exchange loss

A Nigerian company sells goods to a buyer in the US for $550,000, and the customer is given 90 days' credit.

The exchange rate when the goods were shipped was ₦100 = $1.

The customer pays three months later when the exchange rate is ₦100 = $1.10.

When the goods were sold, the expected income in naira was ₦55,000,000 ($550,000 × 100/1).

Because of the change in the exchange rate, the actual naira value of the dollar receipts is just ₦50,000,000 ($550,000 × 100/1.1).

There has been a loss on exchange of ₦5,000,000 in this transaction.

An exporter who is concerned about the risk to income and profit from adverse exchange rate movements during a credit period can 'hedge' the risk by arranging a forward exchange contract.

A **forward exchange contract** is an agreement made 'now' with a bank for the purchase or sale of a quantity of one currency in exchange for another, for settlement at a specified future date.

The exporter would therefore know in advance exactly how much it will be earning in its domestic currency from an export sale.

Forward exchange contracts and other methods of hedging foreign currency risks are explained in more detail in a later chapter.

6 MANAGEMENT OF TRADE PAYABLES

Section overview

- Trade payables as a source of finance
- Settlement discounts from suppliers

6.1 Trade payables as a source of finance

Trade credit is an excellent source for financing short-term working capital needs. The supplier has provided goods or services that have not yet been paid for, and which may or may not already have been used.

Trade credit allows the buyer to hold or make use of goods obtained from suppliers without yet having to pay for them. It therefore postpones the need to find the cash to make payments for goods and services purchased.

Unlike other sources of finance, including a bank overdraft or a bank loan, trade credit does not have any cost.

However, goods are supplied on agreed credit terms. The supplier expects to receive payment at the end of the agreed credit period. If a buyer tries to take advantage of trade credit, and delay payment until after the agreed credit period has ended, the trading relationship between supplier and buyer could become difficult and unfriendly.

A company should therefore take advantage of the trade credit terms it is offered, and negotiate the best credit terms that it can get, because it is a free source of finance for working capital. However it should not exceed the amount of credit allowed.

6.2 Settlement discounts from suppliers

A supplier might offer a settlement discount for early payment. The value of a settlement discount from a supplier should be assessed in the same way as the cost of a settlement discount to customers. If the value of taking the settlement discount is higher than the cost of having to finance the payment by bank overdraft, the discount should be taken and the trade debt should be paid at the latest time possible in order to obtain the discount.

Example: Settlement discounts

Ogechi is offered a 2% settlement discount if it pays invoices from Supplier X in ten days rather than after the normal 30-day credit period. It can borrow on its overdraft at 12% per annum.

The value of the settlement discount is:

$$\left[\left(1+\frac{2}{98}\right)^{\left(\frac{365}{(30-10)}\right)}\right]-1=0.446=44.6\%$$

The value of the settlement discount is much higher than the cost of a bank overdraft.

Ogechi should take the discount and pay invoices on day 10.

7 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the benefits and costs of giving credit
- Explain the components of a receivables management system
- Evaluate the impact of a change in working capital management policy
- Explain debt factoring
- Measure the cost of settlement discounts
- Understand trade payables as a source of short term finance

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

By giving the discount, Entity X is effectively losing ₦1.50 in every ₦100 of its cash receipts from customers to get the money 35 days earlier (45 days – 10 days).

The effective annual cost of the settlement discount is:

$$\left[1+\left(\frac{1.5}{98.5}\right)\right]^{\frac{365}{35}} - 1 = 0.1707, \text{say } 17\%$$

Therefore, offering the settlement discount is not worthwhile. It is cheaper to borrow on overdraft at 15%.

Skills level
Performance management

CHAPTER 24

Cash management

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**			
	2	**Working capital management**		
		a	Discuss the nature, elements and importance of working capital.	
		c	Evaluate and discuss the use of relevant techniques in managing working capital in relation to:	
			iv	Cash (including Baumol and Miller-Orr Models).

Exam context

This chapter explains facets of cash management.

By the end of this chapter, you should be able to:

- Explain the reasons for holding cash balances
- Prepare cash budgets
- Explain and apply the Baumol model of cash management
- Explain and apply the Miller-Orr model of cash management
- Comment on possible uses of surplus cash

1 THE NATURE OF CASH MANAGEMENT

Section overview

- Reasons for holding cash
- Objective of good cash management
- Aspects of cash management

The importance of cash and liquidity for a business was explained in the earlier section on liquidity ratios. If a company is unable to pay what it owes at the required time, a creditor might take legal action to recover the unpaid amount. Even if such extreme action is not taken, but a company is slow in paying invoices, creditors will be reluctant to provide additional credit.

It is therefore essential for a business to ensure that its cash flows are well managed and that it has sufficient liquidity.

1.1 Reasons for holding cash

There are several reasons why a business entity might choose to hold cash.

- To **settle transactions**. Cash is needed to pay expenses, and to settle debts.
- As a **precaution** against unexpected requirements for cash. A business might hold some additional cash in the event that there is a need to make an unexpected and unforeseen payment.
- For **speculative reasons**. A company might hold some cash that can be used if a business opportunity arises. Some investment opportunities, such as the opportunity to purchase a rival business, might require some element of cash. Holding a 'war chest' of cash might therefore be a strategic measure taken by a company, to take opportunities for developing the business whenever an attractive opportunity arises.

However, cash does not earn a high return. Cash in a normal business bank account earns no interest at all. Holding cash therefore provides a company with liquidity (an ability to pay), but reduces profitability (the lost income resulting from holding cash rather than investing it in business development).

1.2 Objective of good cash management

The objective of good cash management is to hold sufficient cash to meet liabilities as they fall due, whilst making sure that not too much cash is held. Money held as cash is not being invested in the wealth-creating assets of the organisation – thereby affecting profitability.

If a business entity wants to maintain sufficient liquidity, but does not want to hold too much cash, it might consider investing cash that is surplus to short-term requirements. Surplus cash can be invested in short-term financial instruments or even savings accounts, and so can earn some interest (although possibly not much) until it is needed. When the cash is eventually needed, the investments can be sold, or cash can be withdrawn from the savings accounts.

1.3 Aspects of cash management

You might be required to consider any of the following three aspects of cash management.

- Forecasting cash flow requirements and operational cash flows. This is done by means of cash budgeting or cash flow forecasting. In your examination it is more likely that you will be required to prepare a cash flow forecast rather than a detailed cash budget.
- Deciding how to invest surplus cash in short-term investments.
- Deciding how much cash to keep and how much to invest in short-term investments. In addition, if money is invested in short-term investments, deciding how many investments to sell in exchange for cash when some cash is eventually needed for operational requirements.

2 CASH BUDGETS AND CASH FLOW FORECASTS

Section overview

- Cash budgets
- Preparing a cash budget
- Cash flow forecasts
- Cash flow statement approach
- Revenue and cost estimation approach
- Free cash flow

2.1 Cash budgets

A cash budget is a detailed plan of cash receipts and cash payments during a planning period. The planning period is sub-divided into shorter periods, and the cash receipts and payments are forecast/planned for each of the sub-divisions of time.

For an annual master budget, the cash budget might be prepared on a monthly basis, or possibly a quarterly basis. Some business entities prepare new cash budgets regularly, possibly forecasting daily cash flows for the next week, or weekly cash flows for the next month.

The main uses of a cash budget are as follows:

- ❑ To forecast how much cash receipts and payments are expected to be over the planning period.
- ❑ To learn whether there will be a shortage of cash at any time during the period, or possibly a cash surplus.
- ❑ If there is a forecast shortage of cash, to consider measures in advance for dealing with the problem - for example by planning to defer some purchases of non-current assets, or approaching the bank for a larger bank overdraft facility.
- ❑ To monitor actual cash flows during the planning period, by comparing actual cash flows with the budget.

2.2 Preparing a cash budget

A cash budget can be prepared by producing a table for the cash receipts and cash payments, containing each item of cash receipt and each item of cash payment. The cash receipts and then the cash payments should be listed in rows of the table, and each column of the table represents a time period, such as one month.

A typical format for a monthly cash budget is shown below.

Example: Cash flow budget

	January	February	March
Cash receipts	₦	₦	₦
Cash sales	5,000	6,000	5,000
Cash from credit sales	72,000	64,000	64,000
Other cash receipts	4,000	2,000	2,000
Total cash receipts	81,000	72,000	71,000
Cash payments			
Cash purchases	6,000	6,600	6,200
Payments for credit purchases	8,400	9,000	9,900
Rental payments	-	30,000	-
Wages and salaries	23,000	23,000	23,000
Dividend payments	-	-	40,000
Other payments	3,000	73,000	13,000
Total cash payments	(40,400)	(141,600)	(92,100)
Receipts minus payments (net cash flow)	40,600	(69,600)	(21,100)
Cash balance at the beginning of the month	45,000	85,600	16,000
Cash balance at the end of the month	85,600	16,000	(5,100)

2.3 Cash flow forecasts

Cash flow forecasts, like cash budgets, are used to predict future cash requirements, or future cash surpluses. However, unlike cash budgets:

- They are prepared throughout the financial year, and are not a part of a formal budget plan
- They are often prepared in much less detail than a cash budget.

The main objectives of cash flow forecasting, like the purposes of a cash budget, are to:

- Make sure that the entity is still expected to have sufficient cash to meet its payment commitments as they fall due
- Identify periods when there will be a shortfall in cash resources, so that financing can be arranged

- Identify whether there will be a surplus of cash, so that the surplus can be invested
- Assess whether operating activities are generating the cash that is expected from them.

The main focus of cash flow forecasting is likely to be operating cash flows, although some investing and financing cash flows might also be significant.

Techniques for preparing a cash flow forecast

There are no rules about how to prepare a cash flow forecast. A forecast need not be in the same amount of detail as a cash budget. However there are two basic approaches that might be used:

- Producing a cash flow forecast similar to a statement of cash flows prepared using the indirect method
- Forecasting cash flows by estimating revenues and costs to arrive at an estimate of earnings before interest, tax and depreciation (EBITDA).

2.4 Cash flow statement approach

One way of preparing a cash flow forecast for a period of time is to produce a statement similar to a statement of cash flows in financial reporting. The general structure of the forecast will therefore be as follows:

Example: Cash flow forecast – statement of cash flows approach

Cash flow forecast

	₦
Expected trading profit in the period	34,000
Adjustments for non-cash items:	
Depreciation	22,000
	56,000
Adjustments for working capital	
Increase in inventory	(15,000)
Increase in trade receivables	(18,000)
Increase in trade payables	10,000
	(23,000)
Operational cash flows	33,000
Interest payments	(10,000)
Tax payments (on profits)	(7,000)
Cash flows from operating activities	**16,000**
Cash flows from investing activities	
Sale of non-current asset	4,000
Purchase of non-current asset	(25,000)
Cash flows from investing activities	**(21,000)**
Cash flows from financing activities	
Repayment of loan	(12,000)
Payment of dividend	(15,000)
Cash flows from financing activities	**(27,000)**
Net change in cash position	**(32,000)**
Cash at beginning of forecast period	40,000
Cash at end of forecast period	8,000

Trading profit (profit before interest and tax)

The expected trading profit might be estimated by projecting the current year's trading profit (profit before interest and tax). For example, if trading profits have been increasing by about 5% per year and were ₦300,000 in the year just ended, it might be assumed for the purpose of the cash forecast that trading profit will be ₦315,000 next year.

Depreciation (and amortisation)

Depreciation is not a cash flow; therefore it must be added back to profit in order to calculate cash flows. Detailed information might be available about non-current assets to enable an accurate estimate of future depreciation charges (and amortisation charges, if there are any intangible assets). Alternatively, it might be assumed that the depreciation charge in the next year will be about the same as in the current year.

An assumption has to be made about depreciation charges, and alternative assumptions might be more appropriate. If you have to make an estimate of depreciation for the purpose of cash flow forecasting in your examination, you should make the most reasonable assumption available on the basis of the information provided in the question.

Changes in inventory, trade receivables and trade payables

The figure for profit must also be adjusted for changes in working capital in order to estimate cash flows from operational activities. The most appropriate assumptions about working capital changes might be one of the following:

- That there will be no changes in working capital
- That inventory, trade receivables and trade payables will increase by the same percentage amount as the growth in sales. For example, if sales are expected to increase by 5%, it might be reasonable to assume that inventory, trade receivables and trade payables will also increase by 5% above their amount at the beginning of the year.

Interest payments and tax payments

Assumptions might be needed about interest and tax payments in the cash flow forecast.

- It might be assumed that interest payments will be the same as interest costs in the current year's income statement, on the assumption that the company's total borrowings will not change significantly and interest rates will remain stable.
- It might be assumed that tax payments will be a percentage of the figure for trading profit.
- However, other assumptions might be more appropriate, given the information provided in an examination question.

Investing cash flows

Investing cash flows might be included in a cash flow forecast if:

- It is expected that additional non-current assets will be purchased in the period
- It is expected that some non-current assets will be sold/disposed of
- It is assumed that some essential replacement of ageing and worn-out non-current assets will be necessary. For example it might be assumed that purchases of replacement non-current assets will be necessary, and the amount of replacements required will be equal approximately to the annual depreciation charge for those assets.

Financing cash flows

It might also be appropriate to include some financing cash flows in the cash flow forecast, where these are expected. In particular, if the company intends to pay an equity dividend, this should be included I n the forecast as a cash outflow.

2.5 Revenue and cost estimation approach

Another approach to preparing a cash flow statement is to estimate earnings before interest, tax, depreciation and amortisation (EBITDA) using estimates of revenues and costs.

Example: Cash flow forecast – Revenue and cost estimation approach

Cash flow forecast

	₦
Sales revenue forecast	300,000
Cost of sales (% of sales revenue)	(180,000)
Gross profit	120,000
Other expenses (possibly fixed, possibly a % of sales revenue)	(90,000)
Net profit	30,000
Add	
Depreciation and amortisation	26,000
EBITDA	56,000

The figure for EBITDA is equivalent to the figure in the cash flow statement for operational cash flows before working capital adjustments. Adjustments can be made to EBITDA for working capital changes, interest and tax payments, investing cash flows and financing cash flows, in order to arrive at an estimate of the net cash flow surplus or deficit for the period.

Sales revenue forecast

The sales revenue forecast should be based on sales revenue in the previous year will an adjustment for volume growth (and possibly an increase in unit sales prices).

Cost of sales and gross profit

If the ratio of cost of sales: sales and the gross profit margin percentage have been fairly stable in recent years, it might be assumed that these ratios will apply in the future.

For example, if sales revenue in the previous year was ₦10 million, gross profit has been 60% of sales for the past few year and sales revenue should increase by 5% next year with volume growth the estimate of gross profit for next year will be ₦10 million × 1.05 × 60% = ₦6.3 million.

Other expenses

The estimate for other expenses should be based on reasonable assumptions. For example it might be assumed that these are fixed costs and so will be unchanged next year. Alternatively, it might be assumed that these costs will be the same percentage amount of sales revenue as in previous years.

Other adjustments might be necessary, to allow for known changes in cost (for example, if an exceptionally large increase in raw material costs is forecast, this will affect the gross profit margin. Other costs might be affected by an expectation of an unusually large increase in administrative labour costs, and so on.

Depreciation and amortisation

If the estimates of cost of sales and other expenses include depreciation costs and amortisation costs, these must be added back in order to obtain an estimate of EBITDA.

Example: Revenue and cost estimation approach

A company wants to make a cash flow forecast for next year. The following information is available.

Annual sales	₦ million
Current year (forecast)	80
Previous year (Year – 1)	75
Year – 2	72
Year – 3	67
Year – 4	64

The company has achieved a gross profit margin of between 57% and 62% in the past four years. Other costs (distribution and administration costs) in the current year are expected to be ₦36 million. Labour costs make up 25% of other costs. These labour costs are expected to rise by 10% per year for the next two years and then in line with the general rate of cost inflation. The general rate of annual cost inflation for the next few years is expected to be 2%.

The company currently has ₦100 million of freehold land (50% land and 50% buildings) and ₦40 million (at cost) of other non-current assets. Buildings are depreciated by 2% per year and other non-current assets are depreciated over eight years by the straight-line method to a zero residual value. The investment in working capital (trade receivables plus inventory, less trade payables) is currently ₦120 million.

Required

Prepare an estimate of cash flows from operations for each of the next two years.

Answer

Sales revenue has grown by a factor of 1.25 (= 80/64) over the past four years. This gives an average annual growth rate in sales of 5.7% (= fourth root of 1.25, minus 1). It might therefore be assumed that sales growth will be 6% per year in each of the next two years.

The gross profit margin has varied between 57% and 62%. It might therefore be assumed that in the next two years gross profit will be 60% sales.

It might also be assumed that growth in sales and the cost of sales allows for 2% per annum price inflation.

Other costs are ₦36 million in the current year, consisting of ₦9 million of labour costs and ₦27 million of other costs. It might be assumed that these are fixed costs, except that they rise by 10% per year in the case of labour and 2% for other costs.

	Current year	Year 1	Year 2
	₦m	₦m	₦m
Labour (growing at 10% per annum)	9	9.9	10.9
Other costs (growing at 2% per annum)	27	27.5	28.1
Total	36	37.4	39.0

Depreciation charges each year are expected to be ₦1 million (2% × ₦50 million) for buildings. For other non-current assets, depreciation will be ₦5 million (= ₦40 million/8 years).

If sales increase by 6% per year, it is assumed that working capital will grow at the same rate, to ₦127 million in Year 1 and ₦135 million in Year 2.

An estimate of EBITDA, adjusted for expected working capital changes, can now be prepared.

	Current Year	Year 1	Year 2
	₦m	₦m	₦m
Revenue	80.0	84.8	89.9
Cost of sales (40%)	(32.0)	(33.9)	(36.0)
Gross profit (60%)	48.0	50.9	53.9
Other costs: see workings	(36.0)	(37.4)	(39.0)
	12.0	13.5	14.9
Depreciation			
Buildings		1.0	1.0
Other non-current assets		5.0	5.0
EBITDA		19.5	20.9
Increase in working capital		(7.0)	(8.0)
EBITDA adjusted for working capital changes		12.5	12.9

2.6 Free cash flow

The concept of free cash flow might also be used in cash flow forecasts. Free cash flow is the amount of surplus cash flow (or the cash flow deficit) after allowing for all cash payments that are essential and non-discretionary. Free cash flow is the amount of cash flow that management is able to use at their discretion for any purpose.

Free cash flow does not have an exact definition, and there may be differences in assumptions about essential cash flows. However, a useful definition of free cash flow is as follows.

Illustration: Free cash flow

	₦
EBITDA	X
Less:	
Payments of interest	(X)
Payments of taxation	(X)
Changes in working capital	X/(X)
(inventory, trade receivables, trade payables)	
Essential capital expenditure (replacement of worn-out assets)	(X)
Free cash flow	X/(X)

Free cash flow can be used to pay dividends, make discretionary purchases of non-current assets, repay debt capital to lenders, or retain as a cash surplus.

Example: Free cash flow

Suppose that in the previous example the company expects to have interest costs of ₦500,000 each year for the next two years, and that taxation will be 25% of EBITDA.

Assume that essential capital expenditure is equal to the depreciation charge on non-current assets.

Required

Estimate free cash flow for the year.

Answer

Free cash flow might therefore be estimated as follows:

	Year 1	Year 2
	₦m	₦m
Revenue	84.8	89.9
Cost of sales (40%)	(33.9)	(36.0)
Gross profit (60%)	50.9	53.9
Other costs: see workings	(37.4)	(39.0)
	13.5	14.9
Depreciation		
Buildings	1.0	1.0
Other non-current assets	5.0	5.0
EBITDA	19.5	20.9
Interest payments	(0.5)	(0.5)
Tax payments (25% of 19.5 and 20.9)	(4.9)	(5.2)
Increase in working capital	(7.0)	(8.0)
Essential capital expenditure	(6.0)	(6.0)
Free cash flow	1.1	1.2

This forecast suggests that after making essential cash payments, the remaining free cash flow will be just over ₦1 million in each year, which might be insufficient to pay for proposed equity dividends or discretionary new capital expenditure projects.

In this example, if the company is hoping to expand it will need to consider ways of raising finance from sources other than operational cash flows.

3 CASH MODELS: BAUMOL MODEL AND MILLER-ORR MODEL

Section overview

- Purpose of cash models
- Baumol model
- Miller-Orr model

3.1 Purpose of cash models

Cash models might be used when an entity has periods of surplus cash and periods when cash is needed. A model can be used to decide:

- How much cash to hold and how much to invest short-term to earn interest; and
- When cash is needed, how many investments to sell (how much cash to obtain).

Two such cash models are the Baumol model and the Miller-Orr model

3.2 Baumol model

The Baumol cash model is based on similar principles to the economic order quantity (EOQ) model used for inventory control. It assumes that a company spends cash regularly on expenses and that to obtain the cash it has to sell short-term investments. The company therefore makes regular sales of investments in order to obtain cash to pay its operational expenses.

The purpose of the Baumol cash model is to calculate the optimal amount of cash that should be obtained each time that short-term investments are sold.

The assumptions used in the model are as follows:

- The company uses cash at a constant rate throughout each year (the same amount of cash every day).
- The company can replenish its cash immediately, as soon as it runs out of the cash it has.
- Cash is replenished by selling short-term investments. These investments earn interest. The amount of investments sold, and the amount of cash from selling the investments, is ₦X.
- Holding cash has a cost. This is the opportunity cost of not investing the cash to earn interest. The opportunity cost, C_H, can be expressed as an interest rate. For example, if investments earn interest at 4% per year, the annual cost of holding cash is 0.04.
- Selling securities or investments to obtain cash has a transaction cost (similar to the cost of placing an order with the EOQ inventory model). In the model, this is shown as C_o.

The maximum amount of cash is therefore X and the average cash holding is $\frac{X}{2}$

The annual cost of holding cash is therefore $\left(\frac{X}{2}\right) \times C_H$

If the annual demand for cash is ₦D, the annual transaction costs of selling securities (short-term investments) is:

$$\left(\frac{D}{X}\right) \times C_o$$

The model identifies the optimal amount of cash to obtain by selling securities, X. It is the amount of cash that minimises the total opportunity costs of holding cash and the transaction costs of selling securities.

The total of $\left[\left(\frac{X}{2}\right) \times C_H\right] + \left[\left(\frac{D}{X}\right) \times C_O\right]$ is minimised where X = $\sqrt{\frac{2C_O D}{C_H}}$

Example: Baumol's cash model

Omegbeoje Nigeria Limited makes payments to its creditors of ₦3 million a year, at an equal rate each day.

Each time it converts investments into cash, it pays transaction charges of ₦150.

The opportunity cost of holding cash rather than investing it is 6% per year.

Using the Baumol model, calculate what quantity of investments should be sold whenever more cash is needed by Entity KL.

Answer

$$x = \sqrt{\frac{2 \times 150 \times 3{,}000{,}000}{0.06}} = ₦122{,}474$$

This might be rounded to ₦122,500.

There would then be ₦3,000,000/₦122,500 = between 24 and 25 transfers of cash during the year.

Practice questions **1**

Nwokocha Nigeria Limited invests all cash as soon as it is received, to earn interest at 5%. It incurs cash expenditures of ₦16,000,000 each year, and pays for these at a constant rate each day. The cost of converting a batch of investments into cash is ₦250, regardless of the size of the transaction.

Required

Use the Baumol model to decide how much cash should be obtained each time investments are sold.

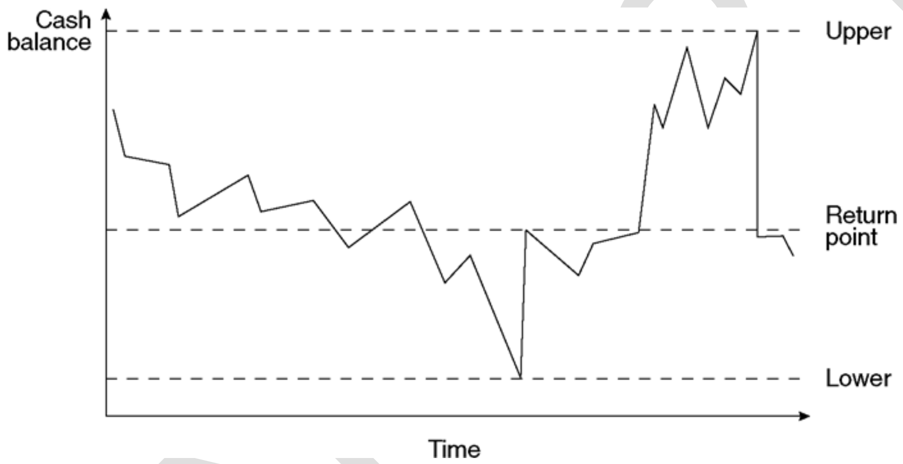
3.3 Miller-Orr model

The Baumol model assumes that cash payments are evenly spread over time, and are a constant amount each period. In reality, this is unlikely to happen. There will be much more uncertainty over the timing of cash payments and receipts.

The Miller-Orr model recognises this uncertainty in cash flows, which are measured statistically. Daily cash flows might be positive or negative. The net daily cash flows are then assumed to be normally distributed around the daily average net cash flow. (However, you do not need to know the statistical details of the model.)

The model is used as follows:

Illustration: Miller-Orr model



The model has a minimum cash holding. This is called the lower limit. This is usually decided by management.

If the cash balance falls to the lower limit, then investments will be converted into cash, to take the balance back to a predetermined amount, known as the return point.

There is also a maximum cash holding limit, the upper limit.

The difference between the lower limit and the upper limit is called the spread.

If the cash balance reaches the upper limit, cash is used to buy investments. The amount of cash used to buy investments is sufficient to return the cash balance to the return point.

The cash balance should therefore fluctuate between the upper and lower limits, and should not exceed these limits.

The distance between the lower limit and the return point is usually 1/3 of the total spread.

The distance between the upper limit and the return point is usually 2/3 of the total spread.

The Miller-Orr model formula for the size of the spread

The Miller-Orr model formula for the size of the spread is as follows:

Formula: The Miller-Orr model formula for the size of the spread

$$\text{Spread} = 3 \times \left(\frac{\frac{3}{4} \times \text{Transaction cost} \times \text{Variance of cash flows}}{\text{Interest rate (as a proportion)}} \right)^{\frac{1}{3}}$$

Notes

(a) The transaction cost is the cost of the sale and purchase of securities

(b) The variance of cash flows is a statistical measure of the variation in the amount of daily net cash flows.. The variance should relate to the same period of time as the interest rate. For example, if the variance is a variance of daily cash flows, the interest rate (expressed as a proportion) must be a daily interest rate. If in doubt, to calculate a daily interest rate from an annual interest rate, divide the annual interest rate by 365. Alternatively, if you prefer to be more exact, take the 365^{th} root (1 + interest rate), then subtract 1 to get the daily interest rate.

(c) To convert an annual variance of cash flows to a daily variance, divide by 365.

(d) Remember also that the variance is the square of the standard deviation (and the standard deviation is the square root of the variance).

(e) A value to the power of one-third means the cube root. Make sure that you have a calculator that can calculate a cube root.

Example: Miller-Orr model

Omotayo Nigeria Limited decides that it needs a minimum cash balance of ₦15,000.

It estimates that it has transaction costs of ₦50 for each purchase or sale of short-term investments.

Based on its measured historical observations, the standard deviation of daily cash flows is ₦1,400.

The annual market interest rate on short-term investments is 8%.

Required

Calculate the upper cash limit and the return point using the Miller-Orr model.

Answer

The variance of daily cash flows = $(1{,}400)^2 = 1{,}960{,}000$.

The daily interest rate = $\frac{0.08}{365} = 0.000219$

Using the formula to calculate the difference between the limits

$$\text{Spread} = 3 \times \left[\frac{\frac{3}{4} \times 50 \times 1{,}960{,}000}{0.000219}\right]^{1/3}$$

= ₦20,848

Lower limit (decided by management) = ₦15,000

Upper limit = ₦15,000 + ₦20,848 = ₦35,848

Return point = ₦15,000 + (1/3 × ₦20,848) = ₦21,949.

Alternative calculation of daily interest rate

Daily interest rate = $\sqrt[365]{(1.08)} = 0.000211$

$$\text{Spread} = 3 \times \left[\frac{\frac{3}{4} \times 50 \times 1{,}960{,}000}{0.000211}\right]^{1/3}$$

= ₦21,108

Lower limit (decided by management) = ₦15,000

Upper limit = ₦15,000 + ₦21,108 = ₦36,108

Practice questions **2**

Enyiola Nigeria Limited decides that it needs a minimum cash balance of

It estimates that it has transaction costs of ₦120 for each purchase or sale of short-term investments.

Based on its measured historical observations, the standard deviation of daily cash flows is ₦1,800.

The annual market interest rate on short-term investments is 7%.

Required

Using the Miller-Orr model, calculate the upper cash limit, and the return point.

4 OTHER ASPECTS OF CASH MANAGEMENT

Section overview

- Use of surplus cash: investing short term
- Ways of investing short term
- Dealing with shortfalls of cash
- Cash management in larger organisations
- Functions of a treasury department

4.1 Use of surplus cash: investing short term

Surplus cash arises when a business entity has cash that it does not need immediately for its day-to-day operations. Surpluses may be short-term (temporary).

When a surplus is identified, the entity should plan how to use it. Holding it as cash is wasteful, because cash in a business bank account earns no interest.

If the surplus is likely to be **long-term**, the cash should be invested long-term in wealth-producing assets of the business – perhaps through a plan of market expansion. Alternatively, if no suitable wealth-producing project is available, the entity should consider returning cash as dividends to its owners – the shareholders.

If the surplus is likely to be **temporary**, it would be more appropriate to invest it for the short term and then cash in the investments when the cash is eventually needed.

When deciding on how to use temporary surplus cash, the following considerations are important:

- **Liquidity –** Short-term investments should ideally be liquid. This means that they should be convertible into cash fairly quickly, at a fair price and without difficulty. The more liquid the investment, the easier it is to convert it back into cash. Market securities can be sold immediately on the market, but at some risk of obtaining a poor price. Money in a savings account can be withdrawn without loss (except perhaps there might be some loss of interest if the money is withdrawn without providing the required minimum notice period).
- **Safety –** The level of investment risk should be acceptable. There is a risk of losing money on the investment, due to a fall in its market value. With investments such as a savings account, there would be no risk of capital loss, but the interest on the savings might be very low. On the other hand investing in shares of other companies is much more risky since share prices fluctuate.
- **Profitability –** The aim should be to earn the highest possible return on the surplus cash, consistent with the objectives of liquidity and safety.

There has to be a trade-off. The greater the liquidity and safety, then generally the lower will be the interest rate earned (profitability).

4.2 Ways of investing short term

There are various possible short-term investment options for cash.

Savings accounts and interest-earning deposits

Savings accounts- Some banks might allow a business to place short-term cash in a savings account. However, banks do not like companies to use a savings account in the same way as a normal current account, with frequent deposits and withdrawals. The bank might insist on a minimum amount of deposit and a minimum notice period for withdrawals.

If the surplus is fairly large, a bank will usually help a business customer to place surplus cash on short-term deposit in the **money markets** (interbank market). Money market rates might be higher than rates on savings accounts.

Money market investments

It is also possible to purchase some **money market investments**, such as Treasury bills and Certificates of Deposit.

Treasury bills are short-term debt instruments issued by the government. They are usually issued by the government for a period of three months (91 days) or possibly six months, and redeemed at the end of that time. They are very secure ('risk-free') since the central government owes the money. They are also very liquid, and can be sold in the market before maturity if required. However, because they are short-term, very liquid and very safe, the rate of return (yield) tends to be low.

(Note: Treasury bills are issued at a discount to their par value and are redeemed at par. For example Nigerian 91-day Treasury bills might be issued at ₦99.00 and redeemed by the government at maturity for ₦100. During the 91-day period the bills can be sold in the market if required, and the market price should move towards ₦100 as the maturity date approaches.)

Certificates of Deposit issued by banks. These are certificates giving their holder the right to ownership of a deposit of cash with the bank, plus interest, at a date in the future (the maturity date for the CD). The market for CDs is liquid, and CDs can be sold easily if the cash is required before the bank deposit reaches maturity.

Short-dated government bonds- The government issues long-dated bonds ('Treasury bonds') as well as short-dated Treasury bills. When these bonds are nearing their maturity, they are an attractive short-term investment. They are as secure as Treasury bills, and possibly even more liquid.

Longer-term securities as short-term investments

Bonds traded in the bond markets. These normally offer a higher return than short-term investments, because there is greater risk for the investor. Bondholders can sell their investment in the secondary bond market if they need to convert the investment back into cash.

However, there is an investment risk. Bond prices can fall if bond yields in the market rise. Bond prices can also fall if the credit rating of the bond issuer falls. In addition, the bond market is not always liquid, so it might also be difficult to sell the bonds for a fair price when the cash is needed. (However, the domestic market for government bonds is normally very liquid. The problem with market liquidity relates more to corporate bonds and the international bond markets.)

Bonds are therefore inadvisable as a short-term investment, unless the investor is willing to accept the risk that bond prices might fall.

Equity. Investing in the shares of other companies is a high-risk investment as there is no guarantee of return of capital value. Share prices can fall as well as rise, and dividend payments are at the discretion of the directors, and usually only paid twice a year. If the shares are quoted, then there will be some liquidity as they will be tradable in the secondary market.

Investing in shares is not recommended as a short-term investment for surplus cash, because of the risk from volatility in share prices.

4.3 Dealing with shortfalls of cash

If the cash flow forecast or the cash budget indicates a shortage of cash, measures must be taken to deal with the problem. An entity must have the cash that it needs to continue in operation.

If the entity does not have short-term investments that it can sell, it will need to obtain long-term capital or short-term funds.

Long-term funding- A company can consider raising long-term funds by issuing new shares for cash.

Alternatively, an entity might be able to borrow long term, by means of issuing loan stock (bonds) or obtaining a medium-term bank loan.

Various **short-term sources of cash** might also be available.

- **Bank overdrafts –** These are very popular with small and medium-sized businesses. Obtaining a bank overdraft is usually the easiest way for a small business to obtain finance.
  - The advantage of a bank overdraft is that the borrower pays interest only on the amount of the overdraft balance.
  - However, overdrafts are expensive (the interest rate is comparatively high compared with other sources of finance). Overdrafts are also are repayable to the bank on demand. The bank can ask for immediate repayment at any time that it wishes. Overdrafts can therefore be a high-risk source of finance, especially for businesses with cash flow difficulties – in other words, the businesses that are usually in greatest need of an overdraft!
  - Bank overdrafts should only be used to finance fluctuating levels of cash shortfalls. If the cash shortfall looks more permanent, other sources of finance should be used.
- **Short-term bank loans** – The main difference between a loan and a bank overdraft is that a loan is arranged for a specific period and the capital borrowed, together with the interest, is repaid according to an agreed schedule and over an agreed time period. They are not repayable on demand before maturity, provided the borrower keeps up the payments. Interest is payable on the full amount of the outstanding loan. However, the bank may demand security for a loan, for example in the form of a fixed and floating charge over the assets of the business.
- **Debt factoring** – Some business entities use the services of a debt factor. The debt factor undertakes to administer the sales receivables ledger of the client business, issuing invoices and collecting payments. In addition, the factor will be prepared to advance cash to the client business in advance of

receiving payment. Typically, a factor will lend a client up to 80% of the value of outstanding trade receivables, and charge interest on the amount of the loan. However, debt factor services can be expensive.

4.4 Cash management in larger organisations

Larger businesses find it much easier than smaller businesses to raise cash when they are expecting a cash shortfall. Similarly, when they have a cash surplus, they find it easier to invest the cash.

Cash management in a large organisation is often handled by a specialist department, known as the **treasury department**. One role of the treasury department is to centralise the control of cash, to make sure that:

- Cash is used as efficiently as possible
- Surpluses in one part of the business (for example, in one profit centre) are used to fund shortfalls elsewhere in the business, and
- Surpluses are suitably invested and mature when the cash is needed.

Making the management of cash the responsibility of a centralised treasury department has significant advantages.

- Cash is managed by specialist staff – improving cash management efficiency.
- All the cash surpluses and deficits from different bank accounts used by the entity can be 'pooled' together into a central bank account. This means that cash can be channelled to where it is needed, and overdraft interest charges can be minimised.
- Central control over cash lowers the total amount of cash that needs to be kept for precautionary reasons. If individual units had to hold their own 'safety stock' of cash, then the total amount of surplus cash would be higher (when added together) than if cash management is handled by one department.
- Putting all the cash resources into one place increases the negotiating power of the treasury department to get the best deals from the banks.

4.5 Functions of a treasury department

The central treasury department is responsible for making sure that cash is available in the right amounts, at the right time and in the right place. To do this, it must:

- Produce regular cash flow forecasts to predict surpluses and shortfalls
- Arrange short-term borrowing and investment when necessary
- Arrange to purchase foreign currency when needed, and arrange to sell foreign currency cash receipts
- Protect the business against the risk of adverse movements in foreign exchange rates, when the business has receipts and payments, or loans and investments
- Deal with the entity's banks
- Finance the business on a day-to-day basis, for example by arranging facilities with a bank
- Advise senior management on long-term financing requirements.

5 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the reasons for holding cash balances
- Prepare cash budgets
- Explain and apply the Baumol model of cash management
- Explain and apply the Miller-Orr model of cash management
- Comment on possible uses of surplus cash

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

$$\sqrt{\frac{2 \times 250 \times 16,000,000}{0.05}} = =400,000$$

Solution **2**

Daily interest rate $= \sqrt[365]{(1.07)} - 1 = 0.000185$

Spread $= 3 \times \left[\frac{{}^{3}/_{4} \times 120 \times (1,800)^2}{0.000185}\right]^{1/3}$ = 3 × ₦11,638 = ₦34,914.

The upper limit = ₦40,000 + ₦34,914 = ₦74,914, say ₦75,000.

The return point = ₦40,000 + ₦11,638 = ₦51,638. This may be rounded to ₦51,500 or ₦52,000.

Skills level
Performance management

CHAPTER 25

Introduction to capital budgeting

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**				
	3	**Capital budgeting decisions**			
		a	Discuss the characteristics of capital budgeting decisions.		
		b	Calculate and discuss various investment appraisal techniques such as:		
			i	Traditional techniques	
				•	Accounting rate of return
				•	Pay-back period

Exam context

This chapter provides an introduction to investment appraisal and explains accounting rate of return method and the payback method of appraising investments. The accounting rate of return method is not mentioned in the syllabus but is a widely used method in practice.

The chapter also provides a revision of how to identify relevant cash flows for use in cash based techniques (payback and discounted cash flow which is covered in the next chapter).

By the end of this chapter, you should be able to:

- Explain the ARR method
- Use the ARR method in project appraisal
- Explain the payback method
- Use the payback method in project appraisal

1 CAPITAL EXPENDITURE, INVESTMENT APPRAISAL AND CAPITAL BUDGETING

Section overview

- Capital expenditure
- Investment appraisal
- Capital budgeting
- Features of investment projects
- Methods of investment appraisal
- The basis for making an investment decision

1.1 Capital expenditure

Capital expenditure is spending on non-current assets, such as buildings and equipment, or investing in a new business. As a result of capital expenditure, a new non-current asset appears on the statement of financial position (balance sheet), possibly as an 'investment in subsidiary'.

In contrast **revenue expenditure** refers to expenditure that does not create long-term assets, but is either written off as an expense in the income statement in the period that it is incurred, or that creates a short-term asset (such as the purchase of inventory).

Capital expenditure initiatives are often referred to as investment projects, or 'capital projects'. They can involve just a small amount of spending, but in many cases large amounts of expenditure are involved.

A distinction might possibly be made between:

- Essential capital spending to replace worn-out assets and maintain operational capability
- Discretionary capital expenditure on new business initiatives that are intended to develop the business make a suitable financial return on the investment.

Examination questions usually focus on discretionary capital expenditure.

1.2 Investment appraisal

Before capital expenditure projects are undertaken, they should be assessed and evaluated. As a general rule, projects should not be undertaken unless:

- They are expected to provide a suitable financial return, and
- The investment risk is acceptable.

Investment appraisal is the evaluation of proposed investment projects involving capital expenditure. The purpose of investment appraisal is to make a decision about whether the capital expenditure is worthwhile and whether the investment project should be undertaken.

1.3 Capital budgeting

Capital expenditure by a company should provide a long-term financial return, and spending should therefore be consistent with the company's long-term corporate and financial objectives. Capital expenditure should therefore be made with the intention of implementing chosen business strategies that have been agreed by the board of directors.

Many companies have a capital budget, and capital expenditure is undertaken within the agreed budget framework and capital spending limits. For example, a company might have a five-year capital budget, setting out in broad terms its intended capital expenditure for the next five years. This budget should be reviewed and updated regularly, typically each year.

Within the long-term capital budget, there should be more detailed spending plans for the next year or two.

- ❑ Individual capital projects that are formally approved should be included within the capital budget.
- ❑ New ideas for capital projects, if they satisfy the investment appraisal criteria and are expected to provide a suitable financial return, might be approved provided that they are consistent with the capital budget and overall spending limits.

Investment appraisal and capital budgets

Investment appraisal therefore takes place within the framework of a capital budget and strategic planning. It involves

- ❑ Generating capital investment proposals in line with the company's strategic objectives.
- ❑ Forecasting relevant cash flows relating to the project
- ❑ Evaluating the projects
- ❑ Implementing projects which satisfy the company's criteria for deciding whether the project will earn a satisfactory return on investment
- ❑ Monitoring the performance of investment projects to ensure that they perform in line with expectations.

1.4 Features of investment projects

Many investment projects have the following characteristics:

- ❑ The project involves the purchase of an asset with an expected life of several years, and involves the payment of a large sum of money at the beginning of the project. Returns on the investment consist largely of net income from additional profits over the course of the project's life.
- ❑ The asset might also have a disposal value (residual value) at the end of its useful life.
- ❑ A capital project might also need an investment in working capital. Working capital also involves an investment of cash.

Alternatively a capital investment project might involve the purchase of another business, or setting up a new business venture. These projects involve an initial capital outlay, and possibly some working capital investment. Financial returns from the investment might be expected over a long period of time, perhaps indefinitely.

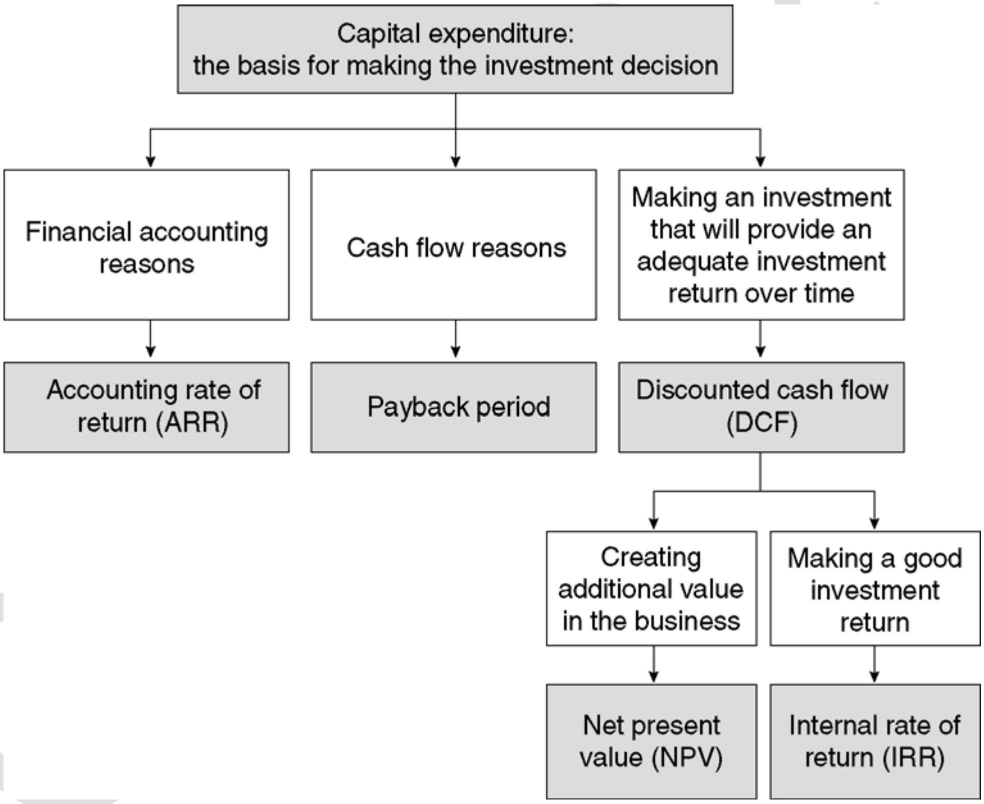
1.5 Methods of investment appraisal

There are four methods of evaluating a proposed capital expenditure project. Any or all of the methods can be used, but some methods are preferable to others, because they provide a more accurate and meaningful assessment.

The four methods of appraisal are:

- ❑ Accounting rate of return (ARR) method
- ❑ Payback method
- ❑ Discounted cash flow (DCF) methods:
  - Net present value (NPV) method
  - Internal rate of return (IRR) method

Each method of appraisal considers a different financial aspect of the proposed capital investment.



1.6 The basis for making an investment decision

When deciding whether or not to make a capital investment, management must decide on a basis for decision-making. The decision to invest or not invest will be made for **financial reasons** in most cases, although non-financial considerations could be important as well.

There are different financial reasons that might be used to make a capital investment decision. Management could consider:

- ❑ the effect the investment will have on the accounting return on capital employed, as measured by financial accounting methods. If so, they might use **accounting rate of return (ARR) /return on investment (ROI)** as the basis for making the decision

- the time it will take to recover the cash invested in the project. If so, they might use the **payback period** as the basis for the investment decision
- the expected investment returns from the project. If so, they should use **discounted cash flow (DCF)** as a basis for their decision. DCF considers both the size of expected future returns and the length of time before they are earned.

There are two different ways of using DCF as a basis for making an investment decision:

- **Net present value (NPV) approach**. With this approach, a present value is given to the expected costs of the project and the expected benefits. The value of the project is measured as the net present value (the present value of income or benefits minus the present value of costs). The project should be undertaken if it adds value. It adds value if the net present value is positive (greater than 0).
- **Internal rate of return (IRR) approach**. With this approach, the expected return on investment over the life of the project is calculated, and compared with the minimum required investment return. The project should be undertaken if its expected return (as an average percentage annual amount) exceeds the required return.

The remainder of this chapter considers the accounting rate of return (ARR) method and the payback method of appraisal.

2 ACCOUNTING RATE OF RETURN (ARR) METHOD

Section overview

- Decision rule for the ARR method
- Definition of ARR
- Advantages and disadvantages of using the ARR method

2.1 Decision rule for the ARR method

The accounting rate of return (ARR) from an investment project is the accounting profit, usually before interest and tax, as a percentage of the capital invested. It is similar to return on capital employed (ROCE), except that whereas ROCE is a measure of financial return for a company or business as a whole, ARR measures the financial return from a specific capital project.

The essential feature of ARR is that it is based on accounting profits, and the accounting value of assets employed. The decision rule for capital investment appraisal using the ARR method is that a capital project meets the criteria for approval if its expected ARR is higher than a minimum target ARR or minimum acceptable ARR.

Alternatively the decision rule might be to approve a project if the return on capital employed (ROCE) of the company as a whole will increase as a result of undertaking the project.

2.2 Definition of ARR

If accounting rate of return (ARR) is used to decide whether or not to make a capital investment, we calculate the expected annual accounting return over the life of the project. The financial return will vary from one year to the next during the project; therefore we have to calculate an **average annual return**.

If the ARR of the project exceeds a target accounting return, the project would be undertaken. If its ARR is less than the minimum target, the project should be rejected and should not be undertaken

Unfortunately, a standard definition of accounting rate of return does not exist. There are two main definitions:

- ❑ Average annual profit as a percentage of the **average investment** in the project
- ❑ Average annual profit as a percentage of the **initial investment**.

You would normally be told which definition to apply. If in doubt, assume that capital employed is the **average** amount of capital employed over the project life.

Formula: Capital employed

$$= \frac{\text{Initial cost of equipment + residual value}}{2} + \text{working capital}$$

However, you might be expected to define capital employed as the total initial investment (capital expenditure + working capital investment).

Profits will vary from one year to the next over the life of an investment project. As indicated earlier, profit is defined as the accounting profit, after depreciation but before interest and taxation. Since profits vary over the life of the project, it is normal to use the **average annual profit** to calculate ARR.

Profit is calculated using normal accounting rules, and is after deduction of depreciation on non-current assets.

Example: Accounting rate of return

A company is considering a project which requires an investment of ₦120,000 in machinery. The machinery will last four years after which it will have scrap value of ₦20,000. The investment in additional working capital will be ₦15,000.

The expected annual profits before depreciation are:

Year	
1	₦45,000
2	₦45,000
3	₦40,000
4	₦25,000

The company requires a minimum accounting rate of return of 15% from projects of this type. ARR is measured as average annual profits as a percentage of the average investment.

Should the project be undertaken?

Answer:

Total project profits before depreciation:	₦
Year 1	45,000
Year 2	45,000
Year 3	40,000
Year 4	25,000
	155,000
Total depreciation = ₦120,000 - ₦20,000	(100,000)
Total project after before depreciation:	55,000
Length of project (÷)	4
Average annual accounting profit	**13,750**
Average investment	
₦(120,000 + 20,000)/2 + ₦15,000	**85,000**
ARR (₦13,750/₦85,000) × 100%	16.2%

2.3 Advantages and disadvantages of using the ARR method

The main **advantages** of the ARR are that:

- ❑ It is fairly easy to understand. It uses concepts that are familiar to business managers, such as profits and capital employed.
- ❑ It is easy to calculate.

However, there are significant **disadvantages** with the ARR method.

- ❑ It is based on accounting profits, and not cash flows. However investments are about investing cash to obtain cash returns. Investment decisions should therefore be based on cash flows, and not accounting profits.
- ❑ Accounting profits are an unreliable measure. For example, the annual profit and the average annual investment can both be changed simply by altering the rate of depreciation and the estimated residual value.
- ❑ The ARR method ignores the timing of the accounting profits. Using the ARR method, a profit of ₦10,000 in Year 1 and ₦90,000 in Year 2 is just as valuable as a profit of ₦90,000 in Year 1 and ₦10,000 in Year 2. However, the timing of profits is significant, because the sooner the cash returns are received, the sooner they can be reinvested to increase returns even more.
- ❑ The ARR is a percentage return, relating the average profit to the size of the investment. It does not give us an absolute return. However the absolute return can be significant. For example if the ARR on an investment of ₦1,000 is 50%, the average profit is ₦500; whereas if the ARR on an investment of ₦1 million is 20%, the average annual profit will be ₦200,000. An accounting return of ₦200,000 on an investment of ₦1 million might be preferred to an accounting return of 50% on an investment of ₦1,000.
- ❑ When using the ARR method for investment appraisal, a decision has to be made about what the minimum target ARR should be. There is no rational economic basis for setting a minimum target for ARR. Any such minimum target accounting return is a subjective target, with no economic or investment significance.

Practice question **1**

A capital project would involve the purchase of an item of equipment costing ₦240,000. The equipment will have a useful life of six years and would generate cash flows of ₦66,000 each year for the first three years and ₦42,000 each year for the final three years.

The scrap value of the equipment is expected to be ₦24,000 after six years. An additional investment of ₦40,000 in working capital would be required.

The business currently achieves a return on capital employed, as measured from the data in its financial statements, of 10%.

Required

(a) Calculate the ARR of the project, using the initial cost of the equipment to calculate capital employed.

(b) Calculate the ARR of the project, using the average cost of the equipment to calculate capital employed.

(c) Suggest whether or not the project should be undertaken, on the basis of its expected ARR.

3 THE PAYBACK METHOD OF CAPITAL INVESTMENT APPRAISAL

Section overview

- Definition of payback
- Decision rule for the payback method
- Advantages and disadvantages of the payback method

3.1 Definition of payback

Payback is measured by **cash flows, not profits**.

It is the length of time before the cash invested in a project will be recovered (paid back) from the net cash returns from the investment project.

For example, suppose that a project will involve capital expenditure of ₦80,000 and the annual net cash returns from the project will be ₦30,000 each year for five years.

The expected payback period is: ₦80.000/₦30,000 = 2.67 years.

3.2 Decision rule for the payback method

Using the payback method, a maximum acceptable payback period is decided, as a matter of policy. The expected payback period for the project is calculated.

- If the expected payback is within the maximum acceptable time limit, the project is acceptable.
- If the expected payback does not happen until after the maximum acceptable time limit, the project is not acceptable.

The **time value of money** is ignored, and the total return on investment is not considered.

Example: Payback

A company requires all investment projects to pay back their initial investment within three years. It is considering a new project requiring a capital outlay of ₦140,000 on plant and equipment and an investment of ₦20,000 in working capital. The project is expected to earn the following net cash receipts:

Year	
1	₦40,000
2	₦50,000
3	₦90,000
4	₦25,000

Should the investment be undertaken?

Answer

Note that 'now' is usually referred to as 'Time 0'.

The investment in working capital should be included as an outflow of cash at the beginning of the project. This is because when there is an increase in working capital, cash flows are lower than cash profits by the amount of the increase.

Similarly when working capital is reduced to ₦0 at the end of the project, the reduction is added to cash flows because when there is a reduction in working capital, cash flows are higher than cash profits by the amount of the reduction.

Year	Cash flow	Cumulative cash position at the end of the year	
	₦		
0	(160,000)	(160,000)	(₦140,000 + ₦20,000)
1	40,000	(120,000)	
2	50,000	(70,000)	
3	90,000	20,000	
4	45,000	65,000	cash flow = ₦25,000 + ₦20,000

(a) If we assume that all cash flows occur at the end of each year, the payback period is three years.

(b) If we assume that cash flows arise evenly over the course of each year, then the payback period is:

2 years + (70,000/90,000) year = 2.78 years = 2 years 9 months.

Note: The payback period of 2 years 9 months is calculated as follow.

(1) Payback occurs during the third year. At the beginning of year 3 the cumulative cash flow is ₦(70,000).

During the year there are net cash flows of ₦90,000.

The cumulative cash flow therefore starts to become positive, assuming even cash flows through the year, after 70,000/90,000 of the year = 0.78 year.

(2) A decimal value for a year can be converted into months by multiplying by 12, or into days by multiplying by 365.

So 0.78 years = 9 months (= 0.78 × 12) or 285 days (= 0.78 × 365).

3.3 Advantages and disadvantages of the payback method

The **advantages** of the payback method for investment appraisal are as follows:

- Simplicity – The payback is easy to calculate and understand.
- The method analyses cash flows, not accounting profits. Investments are about investing cash to earn cash returns. In this respect, the payback method is better than the ARR method.
- Payback is often used together with a DCF method, particularly by companies that have liquidity problems and do not want to tie up cash for long periods. Payback can be used to eliminate projects that will take too long to pay back. Investments that pass the payback test can then be evaluated using one of the DCF methods.

The **disadvantages** of the payback method are as follows:

- It ignores all cash flows after the payback period, and so ignores the total cash returns from the project. This is a significant weakness with the payback method.
- It ignores the timing of the cash flows during the payback period. For example, for an investment of ₦100,000, cash flows of ₦10,000 in Year 1 and ₦90,000 in Year 2 are no different from cash flows of ₦90,000 in Year 1 and ₦10,000 in Year 2, because both pay back after two years. However it is clearly better to receive ₦90,000 in Year 1 and ₦10,000 in Year 2 than to receive ₦10,000 in Year 1 and ₦90,000 in Year 2.

Practice questions **2**

A company must choose between two investments, Project A and Project B. It cannot undertake both investments. The expected cash flows for each project are:

Year	Project A	Project B
	₦	₦
0	(80,000)	(80,000)
1	20,000	60,000
2	36,000	24,000
3	36,000	2,000
4	17,000	-

The company has a policy that the maximum permissible payback period for an investment is three years and if a choice has to be made between two projects, the project with the earlier payback will be chosen.

Required

1) Calculate the payback period for each project:
   (a) assuming that cash flows occur at that year end
   (b) assuming that cash flows after Year 0 occur at a constant rate throughout each year
2) Are the projects acceptable, according to the company's payback rule?
   Which project should be selected?
3) Do you agree that this is the most appropriate investment decision?

4 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain the ARR method
- Use the ARR method in project appraisal
- Explain the payback method
- Use the payback method in project appraisal

SOLUTIONS TO PRACTICE QUESTIONS

1

a) $$\text{ARR} = \frac{18{,}000}{(240{,}000 + 40{,}000)} \times 100\% = 6.4\%$$

Workings

Total cash profits:	₦
Years 1 – 3 (3 × ₦66,000)	198,000
Years 4 – 6 (3 × ₦42,000)	126,000
	324,000
Less depreciation over six years (240,000 – 24,000)	216,000
Total profits	108,000
Average annual profit (÷6)	18,000

b) $$\text{ARR} = \frac{18{,}000}{172{,}000} \times 100\% = 10.5\%$$

Workings

Starting value of the equipment	240,000
Value of the equipment at the end of Year 6	24,000
	264,000
Average capital employed in the equipment (÷ 2)	132,000
Working capital	40,000
Average investment	172,000

c) A project should not be undertaken on the basis of its ARR.

Solution **2**

	Project A		Project B	
Year	**Cash flow**	**Cumulative cash flow**	**Cash flow**	**Cumulative cash flow**
	₦	₦	₦	₦
0	(80,000)	(80,000)	(80,000)	(80,000)
1	20,000	(60,000)	60,000	(20,000)
2	36,000	(24,000)	24,000	4,000
3	36,000	12,000		

1a If cash flows occur at the end of each year, Project A will pay back after three years and Project B will pay back after two years.

1b If cash flows occur at a constant rate throughout the year:

Project A will pay back after:

2 years + [(24,000/36,000) × 12 months] = 2 years 8 months.

Project B will pay back after:

1 year + [(20,000/24,000) × 12 months] = 1 year 10 months.

2) Both projects meet the policy requirement that investments must pay back within three years. The preferred choice would be project B, which pays back more quickly.

3) An investment decision should not be made on the basis of payback alone. Payback ignores the total expected returns from a project. In this example, project A is expected to be more profitable over its full life.

In addition, payback method ignores the time value of money.

Skills level
Performance management

CHAPTER 26

Discounted cash flow

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**				
	3	**Capital budgeting decisions**			
			ii	Discounted cash flow technique	
				•	Net Present Value
				•	Internal Rate of Return
					NB: These may Include basic profitability index and inflation but excluding tax consideration and capital rationing.

Exam context

This chapter explains discounted cash flow and its use in appraising capital investments. Much of the content of this chapter will be familiar to you from an earlier paper.

By the end of this chapter, you should be able to:

- Explain discounting
- Explain NPV and apply the technique in project appraisal
- Explain IRR and apply the technique in project appraisal
- Discuss the relative merits of NPV and IRR
- Distinguish the money cost of capital and the real cost of capital
- Apply the Fisher equation to evaluate an unknown variable
- Explain the link between money cash flows and real cash flows
- Identify money cash flows by taking inflation into account
- Perform discounted cash flow analysis taking inflation into account
- Perform sensitivity analysis and comment on its results
- Explain how risk adjusted discount rates might be used to adjust for project risk
- Explain and calculate discounted payback

1 DISCOUNTING

Section overview

- The time value of money
- Discounting
- Discount tables

1.1 The time value of money

One of the basic principles of finance is that a sum of money today is worth more than the same sum in the future. If offered a choice between receiving ₦10,000 today or in 1 year's time a person would choose today.

A sum today can be invested to earn a return. This alone makes it worth more than the same sum in the future. This is referred to as the time value of money.

The impact of time value can be estimated using one of two methods:

- ❑ Compounding which estimates future cash flows that will arise as a result of investing an amount today at a given rate of interest for a given period.
  - An amount invested today is multiplied by a compound factor to give the amount of cash expected at a specified time in the future assuming a given interest rate.
- ❑ Discounting which estimates the present day equivalent (present value which is usually abbreviated to ***PV***) of a future cash flow at a specified time in the future at a given rate of interest
  - An amount expected at a specified time in the future is multiplied by a discount factor to give the present value of that amount at a given rate of interest.
  - The discount factor is the inverse of a compound factor for the same period and interest rate. Therefore, multiplying by a discount factor is the same as dividing by a compounding factor.
  - Discounting is the reverse of compounding.

1.2 Discounting

Formula: Discount factor

$$\text{Discount factor} = \frac{1}{(1 + r)^n}$$

Where:

r = the period interest rate (cost of capital)

n = number of periods

Example: Discounting

A person expects to receive ₦13,310 in 3 years.

If the person faces an interest rate of 10% what is the present value of this amount?

$$\text{Present value} = \text{Future cash flow} \times \frac{1}{(1+r)^n}$$

$$\text{Present value} = 13{,}310 \times \frac{1}{(1.1)^3}$$

$$\text{Present value} = 10{,}000$$

Emphasis

Illustration: Discounting is the reverse of compounding

Compounding	$\text{Future value} = \text{Amount today} \times (1+r)^n$
Rearranging (and renaming the "amount today" as present value)	$\text{Present value} = \text{Future value} \times \frac{1}{(1+r)^n}$

Interpreting present values

The present value of a future cash flow is the amount that an investor would need to invest today to receive that amount in the future. This is simply another way of saying that discounting is the reverse of compounding.

It is important to realise that the present value of a cash flow is the equivalent of its future value. Using the above example to illustrate this, ₦10,000 today is exactly the same as ₦13,310 in 3 years at an interest rate of 10%. The person in the example would be indifferent between the two amounts. He would look on them as being identical.

Also the present value of a future cash flow is a present day cash equivalent. The person in the example would be indifferent between an offer of ₦10,000 cash today and ₦13,310 in 3 years.

Using present values

Discounting cash flows to their present value is a very important technique. It can be used to compare future cash flows expected at different points in time by discounting them back to their present values.

Example: Comparing cash flows.

A borrower is due to repay a loan of ₦120,000 in 3 years.

He has offered to pay an extra ₦20,000 as long as he can repay after 5 years.

The lender faces interest rates of 7%. Is the offer acceptable?

Existing contract $$PV = 120{,}000 \times \frac{1}{(1.07)^3} = ₦97{,}955$$

Client's offer $$\text{Present value} = 140{,}000 \times \frac{1}{(1.07)^5} = ₦99{,}818$$

The client's offer is acceptable as the present value of the new amount is greater than the present value of the receipt under the existing contract.

Example: Comparing cash flows

An investor wants to make a return on his investments of at least 7% per year.

He has been offered the chance to invest in a bond that will cost ₦200,000 and will pay ₦270,000 at the end of four years.

In order to earn ₦270,000 after four years at an interest rate of 7% the amount of his investment now would need to be:

$$PV = 270{,}000 \times \frac{1}{(1.07)^4} = ₦206{,}010$$

The investor would be willing to invest ₦206,010 to earn ₦270,000 after 4 years.

However, he only needs to invest ₦200,000.

This indicates that the bond provides a return in excess of 7% per year.

Example: Comparing cash flows

How much would an investor need to invest now in order to have ₦100,000 after 12 months, if the compound interest on the investment is 0.5% each month?

The investment 'now' must be the present value of ₦100,000 in 12 months, discounted at 0.5% per month.

$$PV = 100{,}000 \times \frac{1}{(1.005)^{12}} = ₦94{,}190$$

Present values can be used to appraise large projects with multiple cash flows. This is covered in the section 2 of this chapter.

1.3 Discount tables

Discount factors can be calculated as shown earlier but can also be obtained from discount tables. These are tables of discount rates which list discount factors by interest rates and duration.

Illustration: Discount tables (extract)

(Full tables are given as an appendix to this text).

	Discount rates (r)					
(n)	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**
1	0.952	0.943	0.935	0.926	0.917	0.909
2	0.907	0.890	0.873	0.857	0.842	0.826
3	0.864	0.840	0.816	0.794	0.772	0.751
4	0.823	0.792	**0.763**	0.735	0.708	0.683

Where:

n = number of periods

Example: Discount factors from formula or tables

Calculate the present value of ₦60,000 received in 4 years assuming a cost of capital of 7%.

From formula $$\text{PV} = 60{,}000 \times \frac{1}{(1.07)^4} = 45{,}773$$

From table (above) $$\text{PV} = 60{,}000 \times 0.763 = 45{,}780$$

The difference is due to rounding. The discount factor in the above table has been rounded to 3 decimal places whereas the discount factor from the formula has not been rounded.

2 NET PRESENT VALUE (NPV) METHOD OF INVESTMENT APPRAISAL

Section overview

- Introduction to discounted cash flow (DCF) analysis
- Calculating the NPV of an investment project
- Two methods of presentation
- Profitability index

2.1 Introduction to discounted cash flow (DCF) analysis

Discounted cash flow is a technique for evaluating proposed investments, to decide whether they are financially worthwhile.

There are two methods of DCF:

- ❑ **Net present value (NPV) method**: the cost of capital r is the return required by the investor or company
- ❑ **Internal rate of return (IRR) method**: the cost of capital r is the actual return expected from the investment.

All cash flows are assumed to arise at a distinct point in time (usually the end of a year). For example, sales of ₦20m in year four are discounted as if they arose as a single amount at the end of year 4.

2.2 Calculating the NPV of an investment project

Approach

Step 1: List all cash flows expected to arise from the project. This will include the initial investment, future cash inflows and future cash outflows.

Step 2: Discount these cash flows to their present values using the cost that the company has to pay for its capital (cost of capital) as a discount rate. All cash flows are now expressed in terms of 'today's value'.

Step 3: The net present value (NPV) of a project is difference between the present value of all the costs incurred and the present value of all the cash flow benefits (savings or revenues).

- ❑ The project is acceptable if the NPV is positive.
- ❑ The project should be rejected if the NPV is negative.

Example: NPV appraisal

A company with a cost of capital of 10% is considering investing in a project with the following cash flows.

Year	₦(m)
0	(10,000)
1	6,000
2	8,000

Should the project be undertaken?

NPV calculation:

Year	Cash flow	Discount factor (10%)	Present value
	₦(m)		₦(m)
0	(10,000)	1	(10,000)
1	6,000	$\frac{1}{(1.1)}$	5,456
2	8,000	$\frac{1}{(1.1)^2}$	6,612
NPV			2,068

The NPV is positive so the project should be accepted.

Note that the above example refers to year 0, year 1 etc. This actually refers to points in time. "Year 0" is now. "Year 1" is at the end of the first year and so on.

Sometimes they are referred to as t0 (now) , t1 (end of first year), t2 (end of second year) etc.

It is less confusing to think of the project starting at ***time 0*** rather than describing it as ***Year 0*** (as there is no year 0).

Practice questions **1**

1 A company is considering whether to invest in a new item of equipment costing ₦53,000 to make a new product.

The product would have a four-year life, and the estimated cash profits over the four-year period are as follows.

Year	₦
1	17,000
2	25,000
3	16,000
4	12,000

Calculate the NPV of the project using a discount rate of 11%

2 A company is considering whether to invest in a new item of equipment costing ₦65,000 to make a new product.

The product would have a three-year life, and the estimated cash profits over this period are as follows.

Year	₦
1	27,000
2	31,000
3	15,000

Calculate the NPV of the project using a discount rate of 8%

2.3 Two methods of presentation

There are two methods of presenting DCF calculations. Both are shown below, with illustrative figures.

Format 1

Illustration: NPV layout

Year	Description	Cash flow (₦)	Discount factor at 10%	Present value (₦)
0	Machine	(40,000)	1.000	(40,000)
0	Working capital	(5,000)	1.000	(5,000)
1-3	Cash profits	20,000	2.487	49,740
3	Sale of machine	6,000	0.751	4,506
3	Recovery of working capital	5,000	0.751	3,755
	NPV			13,001

Format 2

Illustration: NPV layout

Year	0	1	2	3
	₦	₦	₦	₦
Investment in machine/sale of machine	(40,000)			6,000
Working capital	(5,000)			5,000
Cash receipts		50,000	50,000	50,000
Cash expenditures		(30,000)	(30,000)	(30,000)
Net cash flow	(45,000)	20,000	20,000	31,000
Discount factor at 10%	1.000	0.909	0.826	0.751
Present value	(45,000)	18,180	16,520	23,281
NPV				12,981

For computations with a large number of cash flow items, the second format is probably easier. This is because the discounting for each year will only need to be done once.

Note that **changes in working capital** are included as cash flows. An increase in working capital, usually at the beginning of the project in Year 0, is a cash outflow and a reduction in working capital is a cash inflow. Any working capital investment becomes ₦0 at the end of the project.

2.4 Profitability index

The profitability index can also be used to compare investments.

The profitability index is the ratio of the NPV to capital investment.

Illustration: Profitability index

Following on from the above example the profitability index can be found as follows:

	₦
Net present value	12,981
Investment in machine	÷40,000
Profitability index	0.3245 (or 32.45%)

3 DISCOUNTING ANNUITIES AND PERPETUITIES

Section overview

- Annuities
- Perpetuities
- Application of annuity arithmetic

3.1 Annuities

An annuity is a constant cash flow for a given number of time periods. A capital project might include estimated annual cash flows that are an annuity.

Examples of annuities are:

- ₦30,000 each year for years 1 – 5
- ₦20,000 each year for years 3 – 10
- ₦500 each month for months 1 – 24.

The present value of an annuity can be computed by multiplying each individual amount by the individual discount factor and then adding each product. This is fine for annuities of just a few periods but would be too time consuming for long periods. An alternative approach is to use the annuity factor.

An annuity factor for a number of periods is the sum of the individual discount factors for those periods.

Example:

Calculate the present value of ₦50,000 per year for years 1 – 3 at a discount rate of 9%.

Year	Cash flow	Discount factor at 9%		Present value
1	50,000	$\frac{1}{(1.09)}$	= 0.917	45,850
2	50,000	$\frac{1}{(1.09)^2}$	= 0 842	42,100
3	50,000	$\frac{1}{(1.09)^3}$	= 0.772	38,600
NPV				126,550
or:				
1 to 3	50,000		2.531	126,550

An annuity factor can be constructed by calculating the individual period factors and adding them up but this would not save any time. In practice a formula or annuity factor tables are used.

Formula: Annuity factor (discount factor of an annuity)

There are two version of the annuity factor formula:

	Method 1	Method 2
Annuity factor	$= \frac{1}{r}\left(1 - \frac{1}{(1+r)^n}\right)$	$= \left(\frac{1-(1+r)^{-n}}{r}\right)$

Where:

r = discount rate, as a proportion

n = number of time periods

Example: Present value of an annuity factor

Year	Cash flow	Discount factor	Present value
1 to 3	50,000	2.531 **(W)**	126,550

Working: Calculation of annuity factor

Method 1:

$$= \frac{1}{r}\left(1 - \frac{1}{(1+r)^n}\right)$$

$$= \frac{1}{0.09}\left(1 - \frac{1}{(1.09)^3}\right)$$

$$= \frac{1}{0.09}\left(1 - \frac{1}{1.295}\right)$$

$$= \frac{1}{0.09}(1 - 0.7722)$$

$$= \frac{1}{0.09}(0.2278) = 2.531$$

Method 2:

$$= \left(\frac{1-(1+r)^{-n}}{r}\right)$$

$$= \left(\frac{1-(1.09)^{-3}}{0.09}\right)$$

$$= \left(\frac{1-0.7722}{0.09}\right)$$

$$= \frac{0.2278}{0.09}$$

$$= 2.531$$

Illustration: Annuity factor table (extract)

(Full tables are given as an appendix to this text).

	Discount rates (r)					
(n)	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**
1	0.952	0.943	0.935	0.926	0.917	0.909
2	1.859	1.833	1.808	1.783	1.759	1.736
3	2.723	2.673	2.624	2.577	**2.531**	2.487
4	3.546	3.465	3.387	3.312	3.240	3.170
5	4.329	4.212	4.100	3.993	3.890	3.791

Where:

n = number of periods

Practice questions **2**

1 A company is considering whether to invest in a project which would involve the purchase of machinery with a life of five years

The machine would cost ₦556,000 and would have a net disposal value of ₦56,000 at the end of Year 5.

The project would earn annual cash flows (receipts minus payments) of ₦200,000.

Calculate the NPV of the project using a discount rate of 15%

2 A company is considering whether to invest in a project which would involve the purchase of machinery with a life of four years

The machine would cost ₦1,616,000 and would have a net disposal value of ₦301,000 at the end of Year 4.

The project would earn annual cash flows (receipts minus payments) of ₦500,000.

Calculate the NPV of the project using a discount rate of 10%

3.2 Perpetuities

A perpetuity is a constant annual cash flow 'forever', or into the long-term future.

In investment appraisal, an annuity might be assumed when a constant annual cash flow is expected for a long time into the future.

Formula: Perpetuity factor

$$\text{Perpetuity factor} = \frac{1}{r}$$

Where:

r = the cost of capital

Examples: Present value of perpetuities

Cash flow	Present value
2,000 in perpetuity, starting in Year 1 Cost of capital = 8%	$= \frac{1}{r} \times \text{Annual cash flow}$ $= \frac{1}{0.08} \times 2{,}000 = 25{,}000$

3.3 Application of annuity arithmetic

Equivalent annual costs

An annuity is multiplied by an annuity factor to give the present value of the annuity.

This can work in reverse. If the present value is known it can be divided by the annuity factor to give the annual cash flow for a given period that would give rise to it.

Illustration: Equivalent annual costs

What is the present value of 10,000 per annum from t1 to t5 at 10%?

Time	Cash flow	Discount factor	Present value
1 to 5	10,000	3.791	37,910

What annual cash flow from t1 to t5 at 10% would give a present value of 37,910?

	37,910
Divide by the 5 year, 10% annuity factor	3.791
	10,000

This can be used to address the following problems.

Example: Equivalent annual costs

A company is considering an investment of ₦70,000 in a project. The project life would be five years.

What must be the minimum annual cash returns from the project to earn a return of at least 9% per annum?

Investment = ₦70,000

Annuity factor at 9%, years 1 – 5 = 3.890

Minimum annuity required = ₦17,995 (= ₦70,000/3.890)

Loan repayments

Example: Loan repayments

A company borrows ₦10,000,000.

This is to be repaid by 5 equal annual payments at an interest rate of 8%.

Calculate the payments.

The approach is to simply divide the amount borrowed by the annuity factor that relates to the payment term and interest rate

	₦
Amount borrowed	10,000,000
Divide by the 5 year, 8% annuity factor	3.993
Annual repayment	2,504,383

Sinking funds

A person may save a constant annual amount to produce a required amount at a specific point in time in the future. This is known as a sinking fund.

Example: Sinking fund

A man wishes to invest equal annual amounts so that he accumulates ₦5,000,000 by the end of 10 years.

The annual interest rate available for investment is 6%.

What equal annual amounts should he set aside?

Step 1: Calculate the present value of the amount required in 10 years.

$$PV = 5{,}000{,}000 \times \frac{1}{(1.06)^{10}} = 2{,}791{,}974$$

Step 2: Calculate the equivalent annual cash flows that result in this present value

	₦
Present value	2,791,974
Divide by the 10 year, 6% annuity factor	7.36
Annual amount to set aside	379,344

If the man invests ₦379,344 for 10 years at 6% it will accumulate to ₦5,000,000.

An alternative to the above approach is to use a sinking fund factor.

Formula: Sinking fund factor

There are two version of the annuity factor formula:

$$\text{Sinking fund factor} = \left(\frac{(1+r)^n - 1}{r}\right)$$

Where:

r = interest rate, as a proportion

n = number of time periods

Example: Sinking fund (using sinking fund factor)

A man wishes to invest equal annual amounts so that he accumulates ₦5,000,000 by the end of 10 years.

The annual interest rate available for investment is 6%.

What equal annual amounts should he set aside?

Step 1: Estimate the sinking fund factor

$$=\left(\frac{(1+0.06)^{10}-1}{0.06}\right)=13.181$$

Step 2: Calculate the annual amount to be set aside by dividing the target amount by the sinking fund factor.

	₦
Present value	5,000,000
Divide by the 10 year, 6% sinking fund factor	13.181
Annual amount to set aside	379,344

Slight difference is due to rounding

4 INTERNAL RATE OF RETURN (IRR)

Section overview

- Internal rate of return (IRR)
- Estimating the IRR of an investment project
- IRR as an estimate

4.1 Internal rate of return (IRR)

The internal rate of return method (IRR method) is another method of investment appraisal using DCF.

The internal rate of return of a project is the discounted rate of return on the investment.

- It is the average annual investment return from the project
- Discounted at the IRR, the NPV of the project cash flows must come to zero.
- The internal rate of return is therefore the discount rate that will give a net present value of zero.

The investment decision rule with IRR

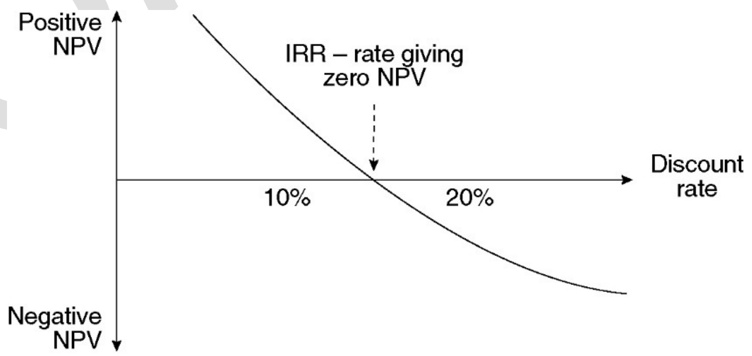
A company might establish the minimum rate of return that it wants to earn on an investment. If other factors such as non-financial considerations and risk and uncertainty are ignored:

- If a project IRR is equal to or higher than the minimum acceptable rate of return, it should be undertaken
- If the IRR is lower than the minimum required return, it should be rejected.

Since NPV and IRR are both methods of DCF analysis, the same investment decision should normally be reached using either method.

The internal rate of return is illustrated in the diagram below:

Illustration: IRR



It is more correct to say that IRR is estimated rather than calculated. This is explained in more detail in the following sections.

4.2 Estimating the IRR of an investment project

To estimate the IRR, you should begin by calculating the NPV of the project at two different discount rates.

- One of the NPVs should be positive, and the other NPV should be negative. (This i**s** not essential. Both NPVs might be positive or both might be negative, but the estimate of the IRR will then be less reliable.)
- Ideally, the NPVs should both be close to zero, for better accuracy in the estimate of the IRR.

When the NPV for one discount rate is positive NPV and the NPV for another discount rate is negative, the IRR must be somewhere between these two discount rates.

Although in reality the graph of NPVs at various discount rates is a curved line, as shown in the diagram above, using the interpolation method we assume that the graph is a straight line between the two NPVs that we have calculated. We can then use linear interpolation to estimate the IRR, to a reasonable level of accuracy.

The interpolation formula

Formula: IRR interpolation formula

$$IRR = A\% + \left(\frac{NPV_A}{NPV_A - NPV_B}\right) \times (B - A)\%$$

Ideally, the NPV at A% should be positive and the NPV at B% should be negative.

Where:

NPV_A = NPV at A%

NPV_B = NPV at B%

Example: IRR

A business requires a minimum expected rate of return of 12% on its investments.

A proposed capital investment has the following expected cash flows.

Year	Cash flow	Discount factor at 10%	Present value at 10%	Discount factor at 15%	Present value at 15%
0	(80,000)	1.000	(80,000)	1,000	(80,000)
1	20,000	0.909	18,180	0.870	17,400
2	36,000	0.826	29,736	0.756	27,216
3	30,000	0.751	22,530	0.658	19,740
4	17,000	0.683	11,611	0.572	9,724
NPV			+ 2,057		(5,920)

Using

$$IRR = A\% + \left(\frac{NPV_A}{NPV_A - NPV_B}\right) \times (B - A)\%$$

$$IRR = 10\% + \left(\frac{2{,}057}{2{,}057 - -5{,}920}\right) \times (15 - 10)\%$$

$$IRR = 10\% + \left(\frac{2{,}057}{2{,}057 + 5{,}920}\right) \times 5\%$$

$$IRR = 10\% + \left(\frac{2{,}057}{7{,}977}\right) \times 5\%$$

$$IRR = 10\% + 0.258 \times 5\% = 10\% + 1.3\%$$

$$IRR = 11.3$$

Conclusion

The IRR of the project (11.3%) is less than the target return (12%).

The project should be rejected.

Practice questions **3**

1 The following information is about a project.

Year	₦
0	(53,000)
1	17,000
2	25,000
3	16,000
4	12,000

This project has an NPV of ₦2,210 at a discount rate of 11%

Estimate the IRR of the project.

2 The following information is about a project.

Year	₦
0	(65,000)
1	27,000
2	31,000
3	15,000

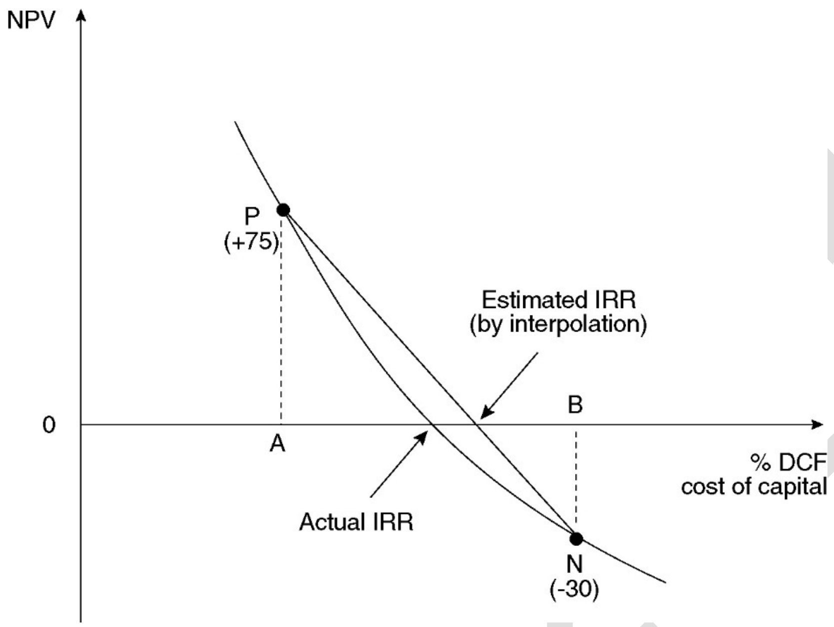
This project has an NPV of ₦(1,515) at a discount rate of 8%

Estimate the IRR of the project.

4.3 IRR as an estimate

The interpolation method is only approximate and is not exact. This is because it assumes that the IRR decreases at a constant rate between the two NPVs.

Illustration: IRR by interpolation



For a 'typical' project, the IRR estimated by the interpolation method is slightly higher than the actual IRR. The interpolation method gives a more accurate estimate of the IRR when:

- both NPVs in the calculation are close to 0; and
- the NPV at A% is positive and the NPV at B% is negative.

(Note that the IRR function in excel estimates IRR in a similar way. However, excel uses the initial IRR to recalculate the NPV and inputs this into a new calculation of IRR, and so on, until it reaches a point where the both NPVs are very close to zero. This means that for all practical purposes, excel calculates the IRR rather than estimates it).

5 RELATIVE MERITS OF NPV AND IRR

Section overview

- Advantages of DCF techniques
- Advantages and disadvantages of the NPV method
- Advantages and disadvantages of the IRR method

5.1 Advantages of DCF techniques

NPV and IRR have several advantages in common.

- Both techniques are based on cash flows rather than accounting profits which are easier to manipulate and more difficult to interpret.
- Both techniques take account of time value. This is a very important variable that is not considered by less sophisticated techniques like return on capital employed.
- Both techniques take account of all cash flows modelled and not just those in a payback period.

5.2 Advantages and disadvantages of the NPV method

Advantages of the NPV method (compared to the IRR method)

NPV provides a single absolute value which indicates the amount by which the project should add to the value of the company.

The NPV decision rule is consistent with the objective of maximisation of shareholders' wealth.

Disadvantages of the NPV method (compared to the IRR method)

The following are often stated as the main **disadvantages** of the NPV method (compared to the IRR method).

Disadvantage	Commentary
The time value of money and present value are concepts that are not easily understood by those without a financial education.	This might be true but decision makers tend to be intelligent and educated people. If they do not understand something, they can have it explained to them).
There might be some uncertainty about what the appropriate cost of capital or discount rate should be for applying to any project. The approach would give a perfect answer in a perfect world but companies do not operate with perfect information so this undermines the usefulness of NPV.	Capital markets may not be perfect but they are often efficient. Companies should be able to arrive at a cost of capital that can be used. Also, the inability to measure a cost of capital could be considered a weakness of the IRR because the IRR has to be measured against a benchmark and the best of these would be the cost of capital.

5.3 Advantages and disadvantages of the IRR method

Advantages of the IRR method (compared to the NPV method)

Advantage	Commentary
The main advantage of the IRR method of investment appraisal (compared to the NPV method) is often given as it is easier to understand an investment return as a percentage return on investment than as a money value NPV.	Commentary: People are used to receiving information based on percentages and so would be more comfortable with the notion of IRR but this does not mean that they would understand it. The supposed simplicity of IRR is an illusion. The percentage return is an average which takes account of time value. Without a certain level of financial education it is difficult to fully appreciate what the percentage answer actually means. Also remember that the decision makers are not the average man on the street. They are clever, educated people so would understand NPV or be in a position to do so.
Another advantage of the IRR method is that it does not require an estimate of the cost of capital.	It is true that it is not necessary to know the cost of capital to calculate the IRR. However, once calculated it must be compared to something and this is usually the cost of capital. Therefore, the cost of capital may not be necessary in the calculation of the IRR but is important in its use.

Disadvantages of the IRR method (compared to the NPV method)

Disadvantage	Commentary
One disadvantage of the IRR method compared to NPV is that it is a relative measure, not an absolute measure. The technique cannot choose between a 10% IRR based on an initial investment of ₦10,000 or a 10% IRR based on an initial investment of ₦10,000,000 or would choose a project with an IRR of 11% on an initial investment of ₦10,000 instead of a 10% IRR based on an initial investment of ₦10,000,000.	This is a weakness of the technique but techniques do not make decisions – people do. A decision maker should be able to understand the difference between these projects even if the technique does not provide that information.

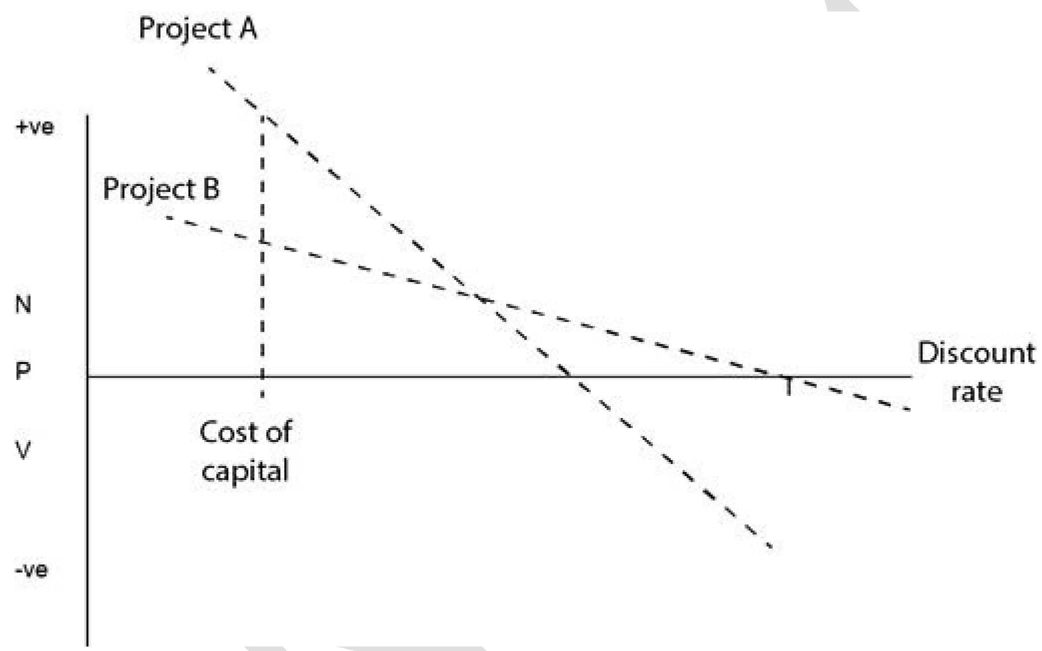
The following disadvantages of IRR compared to NPV are more fundamental.

Mutually exclusive projects

For accept/reject decisions on individual projects, the IRR method will give the same decision as the NPV method. However, in making a choice between two mutually exclusive projects IRR might give a decision that is in conflict with NPV.

Consider the following graphs which illustrate NPV profiles at different costs of capital for two projects.

Illustration: Conflict of NPV and IRR for mutually exclusive projects



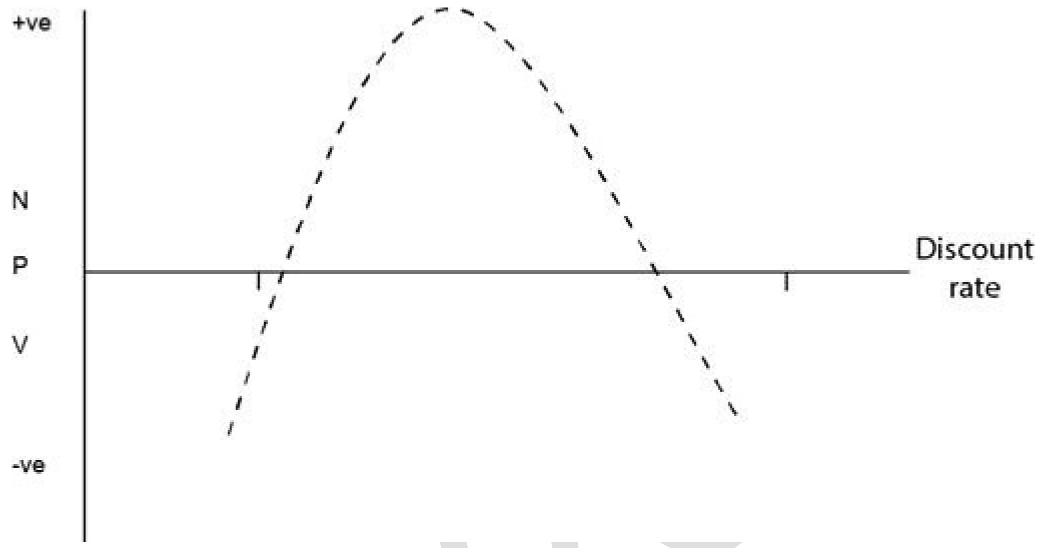
Project A has the higher NPV at the company's cost of capital but project B has the higher IRR.

Resolving the conflict is easy – use NPV! This can be justified on the basis that NPV has a more realistic reinvestment assumption than IRR. The concept of the reinvestment assumption refers to the discount rate used to re-express cash flows in different time terms. The NPV approach "time shifts" values using the cost of capital, whereas the IRR method "time shifts" values using the IRR. It is argued that using the cost of capital is more realistic as this is the cost faced by the company at the date of the appraisal.

Multiple IRRs

Another disadvantage of the IRR method is that a project might have two or more different IRRs, when some annual cash flows during the life of the project are negative. How should the different IRRs be interpreted?

Illustration: Multiple IRRs



6 DCF AND INFLATION

Section overview

- Inflation and long-term projects
- Discounting money cash flows at the money cost of capital
- Discounting real cash flows at the real cost of capital

6.1 Inflation and long-term projects

When a company makes a long-term investment, there will be costs and benefits for a number of years. In all probability, the future cash flows will be affected by inflation in sales prices and inflation in costs. DCF analysis should take inflation into account.

There are two ways of incorporating inflation into DCF analysis. A company should either:

- ❑ Discount the money cash flows at the money cost of capital; or
- ❑ Discount the real terms cash flows at the real cost of capital.

Discounting real cash flows using a real cost of capital will give the same NPV as discounting money cash flows using the money cost of capital, where the same rate of inflation applies to all items of cash flow.

Money/real cash flows

Real terms cash flows are what an item would cost or be sold for in current prices (i.e. before considering inflation).

Money cash flows refer to the amount that is actually received or paid at different points in time in the future (i.e. taking inflation into account. The money cash flows are estimated by initially pricing cash flows at current prices and then inflating them by the expected inflation rates.

Example: Money/real cash flows

A component costs ₦1,000 at today's prices

Inflation for the next two years is expected to be 4% per year

The component will cost ₦1,082 (₦1,000 × 1.04 × 1.04) in 2 years

₦1,000 is the cost of the component in real terms (real terms cash flow)

₦1,082 is the cost of the component in money terms (money cash flow)

Money/real cost of capital

Cost of capital is explained in detail in later chapters but briefly it is the rate of return required by the investors for investing in a project of a given risk. The models covered later estimate the money cost of capital.

Real cost of capital is the return that investors would require without inflation.

Money cost of capital is the return that investors would require with inflation. It follows that the money cost is higher than the real cost in times of inflation. Investors want a return to compensate them for the risk in the project and an extra return to compensate them for the value of money falling.

A real rate of return can be calculated using the relationship

Formula: Link between money cost, real cost and inflation (Fisher equation)

$$1 + m = (1 + r)(1+i)$$

Where:

m = money cost of capital

r = real cost of capital

I = inflation rate

Example: Money cost of capital to real cost of capital

If a company has a cost of capital of 12% and inflation is 5%

Therefore:

$$(1 + m) = (1 + r) \times (1 + i)$$
$$(1 + 0.12) = (1 + r) \times (1 + 0.05)$$
$$(1 + r) = 1.12/1.05$$
$$r = 1.12/1.05 - 1 = 0.0667 \text{ or } 6.67\%$$

Information availability

In practice companies would have access to current prices and the money cost of capital. In order to perform DCF one or other of these must be changed.

Either the money cost of capital is restated to the real cost and this is used to discount the cash flows expressed in current terms, or the cash flows expressed in current prices are inflated and these are discounted at the money cost.

The second of these approaches is the most commonly used and should be adopted by you unless a question tells you otherwise.

6.2 Discounting money cash flows at the money cost of capital

The cost of capital used in DCF analysis is normally a **'money' cost of capital**. This is a cost of capital calculated from current market returns and yields.

When estimates are made for inflation in future cash flows, the rules are as follows:

- Estimate all cash flows at their inflated amount. Since cash flows are assumed to occur at the year-end, they should be increased by the rate of inflation for the full year.
- To estimate a future cash flow at its inflated amount, you can apply the formula:

  Cash flow in year n at inflated amount = [Cash flow at current price level] × $(1 + i)^n$ (where i is the annual rate of inflation).
- Discount the inflated cash flows at the money cost of capital, to obtain present values for cash flows in each year of the project and the NPV for the project.

Example: Discounting money cash flows at the money cost of capital

A company is considering an investment in an item of equipment costing ₦150,000. The equipment would be used to make a product. The selling price of the product at today's prices would be ₦10 per unit, and the variable cost per unit (all cash costs) would be ₦6.

The project would have a four-year life, and sales are expected to be:

Year	Units of sale
1	20,000
2	40,000
3	60,000
4	20,000

At today's prices, it is expected that the equipment will be sold at the end of Year 4 for ₦10,000. There will be additional fixed cash overheads of ₦50,000 each year as a result of the project, at today's price levels.

The company expects prices and costs to increase due to inflation at the following annual rates:

Item	Annual inflation rate
Sales	5%
Variable costs	8%
Fixed costs	8%
Equipment disposal value	6%

The company's money cost of capital is 12%. Ignore taxation.

Required

Calculate the NPV of the project.

All the cash flows must be re-stated at their inflated amounts. An assumption needs to be made about what the cash flows will be in Year 1. Are 'today's' price levels the price levels to use in Year 1, or should the cash flows in Year 1 be increased to allow for inflation?

An examination question might tell you which assumption to use. If it does not, state your assumption in the answer. The usual assumption is that information is given in current prices so that Year 1 cash flows (which the model assumes to occur at the end of Year 1) must be inflated. This assumption is used to answer this question.

Answer

Item	**Time 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
	₦	₦	₦	₦	₦
Initial outlay	(150,000)				
Disposal (₦10k × $(1.06)^4$)					12,625
Revenue					
At today's prices		200,000	400,000	600,000	200,000
Inflation factor		× 1.05	× 1.05^2	× 1.05^3	× 1.05^4
Money cash flows		210,000	441,000	694,575	243,101
Costs					
Variable (current prices)		120,000	240,000	360,000	120,000
Fixed (current prices)		50,000	50,000	50,000	50,000
Total (current prices)		170,000	290,000	410,000	170,000
Inflation factor		× 1.08	× 1.08^2	× 1.08^3	× 1.08^4
Money cash flows		183,600	338,256	516,482	231,283
Net cash flow	(150,000)	26,400	102,744	178,093	24,443
Discount factors (at 12%)	1.000	0.893	0.797	0.712	0.636
	(150,000)	23,575	81,886	126,802	15,546
NPV					97,809

Practice question **4**

A company is considering whether or not to invest in a five-year project. The investment will involve buying an item of machinery for ₦200,000.

At today's prices, the annual operating cash flows would be:

Year	Revenues	Running costs
	₦	₦
1	200,000	100,000
2	200,000	100,000
3	250,000	125,000
4	150,000	75,000
5	100,000	50,000

Revenues are expected to go up by 7% each year due to inflation, and costs are expected to go up by 12% per year due to inflation.

The machinery is expected to have a re-sale value at the end of year 5 of ₦20,000 at today's prices, but this amount is expected to rise by 5% each year due to inflation.

The cost of capital is 16%.

Required

Calculate the NPV of the investment project.

6.3 Discounting real cash flows at the real cost of capital

The cost of capital given for use in DCF analysis is normally a 'money' rate of return (also known as a **nominal rate of return**). The money rate of return should be used to discount money cash flows which have been adjusted to take into account inflation increases.

An alternative approach to DCF analysis is to discount real cash flows using a real cost of capital. Real cash flows are shown at today's prices.

Example: Both methods

A company is considering an investment in an item of equipment costing ₦150,000. Contribution per unit is expected to be ₦4 and sales are expected to be:

Year	Units
1	20,000
2	40,000
3	60,000
4	20,000

Fixed costs are expected to be ₦50,000 at today's price levels and the equipment can be disposed of in year 4 for ₦10,000 at today's price levels. The inflation rate is expected to be 6% and the money cost of capital is 15%.

Required

Calculate the NPV of the project:

(a) using money cash flows and the money cost of capital

(b) using the real value of cash flows and the real cost of capital

Answer

(a) Using money cash flows and a money discount rate

Item	Time 0	Year 1	Year 2	Year 3	Year 4
	₦	₦	₦	₦	₦
Initial outlay	(150,000)				
Contribution		80,000	160,000	240,000	80,000
Fixed costs		(50,000)	(50,000)	(50,000)	(50,000)
Disposal proceeds					10,000
Net cash flow (at today's prices)	(150,000)	30,000	110,000	190,000	40,000
Adjust for inflation		× 1.06	× 1.06^2	× 1.06^3	× 1.06^4
Money cash flows	(150,000)	31,800	123,596	226,293	50,499
Discount at 15%	1.000	0.870	0.756	0.658	0.572
Present value	(150,000)	27,666	93,439	148,901	28,885
NPV					148,891

(b) Using real cash flows and a real discount rate

The real discount rate = 1.15/1.06 – 1 = 0.085 = 8.5%

Item	Time 0	Year 1	Year 2	Year 3	Year 4
	₦	₦	₦	₦	₦
Initial outlay	(150,000)				
Contribution		80,000	160,000	240,000	80,000
Fixed costs		(50,000)	(50,000)	(50,000)	(50,000)
Disposal proceeds					10,000
Net cash flow (at today's prices)	(150,000)	30,000	110,000	190,000	40,000
Discount at 8.5%		1/1.085	$1/1.085^2$	$1/1.085^3$	$1/1.085^4$
Present value	(150,000)	27,650	93,440	148,753	28,863
					148,706

Both approaches give the same solution, with a small difference due to rounding errors.

7 RISK AND UNCERTAINTY IN CAPITAL INVESTMENT APPRAISAL

Section overview

- The problem of risk and uncertainty
- Methods of assessing risk and uncertainty

7.1 The problem of risk and uncertainty

Investment projects are long-term projects, often with a time scale of many years. When the cash flows for an investment project are estimated, the estimates might be incorrect. Estimates of cash flows might be wrong for two main reasons:

- Risk in the investment, and
- Uncertainty about the future.

Risk

Risk exists when the actual outcome from a project could be any of several different possibilities, and it is not possible in advance to predict which of the possible outcomes will actually occur.

The simplest example of risk is rolling a dice. When a dice is rolled, the result will be 1, 2, 3, 4, 5 or 6. These six possible outcomes are known in advance, but it is not possible in advance to know which of these possibilities will be the actual outcome. With risk assessment, it is often possible to estimate the probabilities of different outcomes. For example, we can predict that the result of rolling a dice will be 1, 2, 3, 4, 5 or 6, each with a probability of 1/6.

Risk can often be measured and evaluated mathematically, using probability estimates for each possible future outcome.

Uncertainty

Uncertainty exists when there is insufficient information to be sure about what will happen, or what the probability of different possible outcomes might be. For example, a business might predict that sales in three years' time will be ₦500,000, but this might be largely guesswork, and based on best-available assumptions about sales demand and sales prices.

Uncertainty occurs due to a lack of sufficient information about what is likely to happen.

It is possible to assess the uncertainty in a project, but with less mathematical precision than for the assessment of risk.

Management should try to evaluate the risk and uncertainty, and take it into account, when making their investment decisions. In other words, investment decisions should consider the risk and uncertainty in investment projects, as well as the expected returns and NPV.

7.2 Methods of assessing risk and uncertainty

There are several methods of analysing and assessing risk and uncertainty. In particular:

- Sensitivity analysis can be used to assess a project when there is uncertainty about future cash flows;
- Risk-adjusted discount rates; and
- Using discounted payback as one of the criteria for investing in capital projects.

8 SENSITIVITY ANALYSIS

Section overview

- The purpose of sensitivity analysis: assessment of project uncertainty
- “What if” testing
- Sensitivity testing
- Estimating the sensitivity of a project to changes in the cost of capital
- Estimating the sensitivity of a project to changes in project life
- The usefulness of sensitivity analysis

8.1 The purpose of sensitivity analysis: assessment of project uncertainty

Sensitivity analysis is a useful but simple technique for assessing investment risk in a capital expenditure project when there is uncertainty about the estimates of future cash flows. It is recognised that estimates of cash flows could be inaccurate, or that events might occur that will make the estimates wrong.

The purpose of sensitivity analysis is to assess how the NPV of the project might be affected if cash flow estimates are worse than expected.

There are two main methods of carrying out sensitivity analysis on a capital expenditure project.

Method 1

Sensitivity analysis can be used to calculate the effect on the NPV of a given percentage reduction in benefits or a given percentage increase in costs. For example:

- What would the NPV of the project be if sales volumes were 10% below estimate?
- What would the NPV of the project be if annual running costs were 5% higher than estimate?

The percentage variation in the expected cash flows should be an amount that might reasonably occur, given the uncertainty in the cash flow estimates.

There are also forms of ‘stress testing’, similar to sensitivity analysis, that might be used to assess the investment risk. An assessment could be made to estimate the effects of:

- Of an unexpected event occurring in the future that would make the cash flow estimates for the project wrong; or
- The effect of a delay is that the expected cash inflows from the project

occur later than planned.

This sort of analysis is sometimes called ***"what if?"*** analysis.

Method 2

Alternatively, sensitivity analysis can be used to calculate the percentage amount by which a cash flow could change before the project NPV changed. For example:

- ❑ By how much (in percentage terms) would sales volumes need to fall below the expected volumes, before the project NPV became negative?
- ❑ By how much (in percentage terms) would running costs need to exceed the expected amount before the NPV became negative?

8.2 "What if" testing

Example: What if testing

A company is considering the following project.

Item	Time 0	Year 1	Year 2	Year 3	Year 4
	₦	₦	₦	₦	₦
Initial outlay	(55,000)				
Income		50,000	80,000	100,000	40,000
Running costs		(35,000)	(55,000)	(70,000)	(30,000)
Net cash flow	(55,000)	15,000	25,000	30,000	10,000
Discount factors (at 10%)	1.000	0.909	0.826	0.751	0.683
	(55,000)	13,635	20,650	22,530	6,830
NPV					8,645

Required

Estimate the sensitivity of the project to income being 5% lower than forecast. (What if sales were 5% lower than forecast?)

Answer

The change must be incorporated into the cash flows and the NPV must be recalculated.

Item	Time 0	Year 1	Year 2	Year 3	Year 4
	₦	₦	₦	₦	₦
Initial outlay	(55,000)				
Income (95%)		47,500	76,000	95,000	38,000
Running costs		(35,000)	(55,000)	(70,000)	(30,000)
Net cash flow	(55,000)	12,500	21,000	25,000	8,000
Discount factors (at 10%)	1.000	0.909	0.826	0.751	0.683
	(55,000)	11,363	17,346	18,775	5,464
NPV					(2,053)

This analysis shows that if income is 5% less than expected, the NPV will be negative and the project would fail to provide a 10% return.

Practice question **1**

Estimate the sensitivity of the project to running costs being 5% higher than forecast.

8.3 Sensitivity testing

An alternative method of sensitivity analysis is to calculate by how much cash flows need to be worse than expected before a decision would change (where the NPV becomes negative). This is described as method 2 above

This requires the calculation of the present value of each input cash flow. The NPV can then be compared to this to see by how much it would have to change before the NPV were to fall to zero.

Example: What if testing

A company is considering the following project.

Item	Time 0	Year 1	Year 2	Year 3	Year 4
	₦	₦	₦	₦	₦
Initial outlay	(55,000)				
Income		50,000	80,000	100,000	40,000
Running costs		(35,000)	(55,000)	(70,000)	(30,000)
Net cash flow	(55,000)	15,000	25,000	30,000	10,000
Discount factors (at 10%)	1.000	0.909	0.826	0.751	0.683
	(55,000)	13,635	20,650	22,530	6,830
NPV					8,645

Required

Estimate the sensitivity of the project to income being lower than forecast.

Answer

The NPV will become negative if the PV of any cost is more than ₦8,645 above estimate or if the PV of benefits is more than ₦8,645 below estimate.

Step 1: Calculate the present value of the income stream.

Item	Year 1	Year 2	Year 3	Year 4
	₦	₦	₦	₦
Income (95%)	50,000	80,000	100,000	40,000
Discount factors (at 10%)	0.909	0.826	0.751	0.683
	45,450	66,080	75,100	27,230
PV of income				213,950

Step 2: Compare the NPV of the project to this number to estimate the percentage change that would reduce the NPV to zero (at which point the decision would change).

The project would cease to have a positive NPV if income is below the estimate by more than (8,645/213,950) = 0.040 or 4.0%.

Practice questions **2**

Using the information from the previous example:

a) Estimate the project's sensitivity to the equipment costs being higher than expected.

b) Estimate the project's sensitivity to running costs being higher than expected.

8.4 Estimating the sensitivity of a project to changes in the cost of capital

The sensitivity of the project to a change in the cost of capital can be found by calculating the project IRR. This can be compared with the company's cost of capital.

Example: Sensitivity of a project to changes in the cost of capital

A company is considering the following project:

Year	Net cash flow	DCF factor at 15%	PV	DCF factor at 20%	PV
	₦		₦		₦
0	(55,000)	1.000	(55,000)	1.000	(55,000)
1	15,000	0.870	13,050	0.833	12,495
2	25,000	0.756	18,900	0.694	17,350
3	30,000	0.658	19,740	0.579	17,370
4	10,000	0.572	5,720	0.482	4,820
NPV			2,410		(2,965)

IRR = 15% + [2,410 / (2,410 + 2,965)] × (20 – 15)% = 17.2%

The sensitivity of the project to changes in the cost of capital is quite small. The cost of capital is 10% but the cost of capital would have to be over 17.2% before the NPV became negative.

This is a rise of 7.2% in absolute terms and 72% in relative terms. (Be careful when you make statements like this about cost of capital).

8.5 Estimating the sensitivity of a project to changes in project life

The sensitivity of the project to a change in the project life can be found by changing the project life until the NPV changes sign.

Example: Sensitivity of a project to changes in its life

A company is considering the following project:

Year	Net cash flow	DCF factor at 15%	PV
	₦		₦
0	(55,000)	1.000	(55,000)
1	15,000	0.870	13,050
2	25,000	0.756	18,900
3	30,000	0.658	19,740
4	10,000	0.572	5,720
NPV			2,410

If the project lasted only four years the company would not receive the year 4 cash flow of 5,720 causing the NPV to fall to 2,410 – 5,720 = (3,310).

Therefore, the project would have a zero NPV sometime during the third year. The point can be estimated by interpolation (using a similar approach to that used to calculate IRR) as follows:

Project life that would generate a zero NPV =

4 years – [2,410 / (2,410 + 3,310)] × (4 – 3) years = 3.578 years.

(Alternatively: 3 years + 3,310/(2,410 + 3,310)] × (4 – 3) years = 3.578 years.)

Thus the project duration would need to fall from 4 years to 3.6 years (say) in before the NPV became negative. This is fall of 0.4 years which is 10% of the original project life of 4 years.

A problem with the above approach is that it assumes that the cash flows in year 4 arise evenly through the period but the NPV calculation itself assumes that all cash flows arise on the last day of the period (or at least at discrete points in time). However, it does allow an approximation of the sensitivity of the project to the life of the project.

8.6 The usefulness of sensitivity analysis

Sensitivity analysis is useful because it directs management attention to the critical variables in the project. These are the variables where a variation in the cash flows by a fairly small amount – and certainly by an amount that might reasonably be expected, given uncertainty about the cash flows – would make the NPV negative and the project not financially viable.

- ❑ If the project is undertaken, sensitive items of cash flow should be closely monitored and action taken if they vary from plan.
- ❑ If a project NPV is particularly sensitive to an item of cost or revenue, management might decide to reject the project because of the investment risk involved.

A major problem with sensitivity analysis is that only one variable is varied at a time and it is assumed that all variables are independent of each other. In reality variables may all vary to some extent and they may be interdependent. For this reason simulation models may provide additional information when assessing risk.

9 OTHER METHODS OF RISK AND UNCERTAINTY ANALYSIS

Section overview

- Risk adjusted discount rates
- Discounted payback period

9.1 Risk adjusted discount rates

The calculation of NPV involves modelling the project cash flows and then discounting them.

The discount rate should always reflect the risk of the underlying cash flows being discounted.

The weighted average discount rate (WACC) of a company is the rate of return required by its owners to compensate them for tying up their capital in that company. The owners decide on the level of return they require for investing in a company by comparing the risk of the company to the risk of alternative investment opportunities. Therefore, in a very real sense, the WACC of a company reflects the risk of that company's assets and returns. The WACC of capital of a company reflects the risk of that company.

It is only appropriate for a company to use its WACC as a discount rate if the risk of the project is the same as the overall risk of the company. If this is not the case an alternative rate should be used to reflect the risk of the project.

Discount rates are increased to reflect future cash inflows of higher risk. The use of a higher discount rate results in a lower NPV. This is as would be expected.

Suppose a business expected two receipts of ₦10,000 in one year's time but one of these was more risky than the other. In that case the riskier asset would be worth less. A higher discount rate would achieve this.

Source of risk adjusted discount rates

In practice the treasury department of a multinational might provide a list of rates to be used to appraise projects of different types. For example they might specify 10% for asset replacement decisions but 12% for expansion decisions which by their nature are more risky. Such rates should be derived from a capital asset pricing model (CAPM) based approach but this is not always the case.

The CAPM will be explained in a later chapter. It is a technique which provides the required rate of return for an appropriate level of risk (measured as □) by adding a risk premium to the risk free rate.

Risk adjusted discount rates for negative cash flows

Discount rates are **increased** to reflect future cash **inflows** of higher risk. The use of a higher discount rate results in a lower positive NPV for a higher risk cash inflow.

Discount rates are **decreased** to reflect future cash **outflows** of higher risk. The use of a lower discount rate results in a higher negative NPV for a higher risk cash outflow. This is as would be expected.

Suppose a business faced two payments of ₦10,000 in one year's time but one of these was more risky than the other. In that case the riskier liability would be more expensive. A third party would demand a greater sum to take the risky liability than it would to take the less risky. A lower discount rate would achieve this.

9.2 Discounted payback period

Instead of using the ordinary payback to decide whether a project is acceptable, discounted payback might be used as an alternative. A maximum discounted payback period is established and projects should not be undertaken unless they pay back within this time.

A consequence of applying a discounted payback rule (and the same applies to ordinary payback) is that projects are unlikely to be accepted if they rely on cash profits in the long-term future to make a suitable financial return. Since longer-term estimates of cash flows are usually more unreliable than estimates in the shorter-term, using discounted payback as a criterion for project selection will result in the rejection of risky projects.

A discounted payback period is calculated in the same way as the 'ordinary' payback period, with the exception that the cash flows of the project are converted to their present value. The discounted payback period is the number of years before the cumulative NPV of the project reaches zero.

Example: Discounted payback

Discounted payback period is calculated as follows.

Year	Annual cash flow (₦)	Discount factor (10%)	PV of cash flow (₦)	Cumulative NPV (₦)
0	(200,000)	1.000	(200,000)	(200,000)
1	(40,000)	0.909	(36,360)	(236,360)
2	30,000	0.826	24,780	(211,580)
3	120,000	0.751	90,120	(121,460)
4	150,000	0.683	102,450	(19,010)
5	100,000	0.621	62,100	43,090
6	50,000	0.564	28,200	71,290
NPV			71,290	

The discounted payback period is Year 5, and we can estimate it in years and months as:

4 years + (19,010/62,100) × 12 months = 4 years 4 months

The discounted period for a capital investment is always longer than the 'ordinary' non-discounted payback period.

Advantages of discounted payback

It is easy to understand and to calculate.

It takes account of time value of money.

It provides insight into liquidity and uncertainly risk. Projects with shorter payback periods are better for company liquidity. Therefore, the shorter the payback period, the lower the overall risk of a project.

Disadvantages of discounted payback

One criticism of the discounted payback method of project evaluation is the same as for the non-discounted payback method. It ignores the expected cash flows from the project after the payback period has been reached. Therefore, it might lead to rejection of projects with a positive NPV.

There is no way of determining how long an acceptable payback period should be. Therefore, the choice of a project on the basis of the payback criterion is an arbitrary decision.

10 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain discounting
- Explain NPV and apply the technique in project appraisal
- Explain IRR and apply the technique in project appraisal
- Discuss the relative merits of NPV and IRR
- Distinguish the money cost of capital and the real cost of capital
- Apply the Fisher equation to evaluate an unknown variable
- Explain the link between money cash flows and real cash flows
- Identify money cash flows by taking inflation into account
- Perform discounted cash flow analysis taking inflation into account
- Perform sensitivity analysis and comment on its results
- Explain how risk adjusted discount rates might be used to adjust for project risk
- Explain and calculate discounted payback

SOLUTIONS TO PRACTICE QUESTIONS

Solutions **1**

1 NPV calculation:

Year	Cash flow	Discount factor (11%)	Present value
0	(53,000)	1	(53,000)
1	17,000	$\frac{1}{(1.11)}$	15,315
2	25,000	$\frac{1}{(1.11)^2}$	20,291
3	16,000	$\frac{1}{(1.11)^3}$	11,699
4	12,000	$\frac{1}{(1.11)^4}$	7,905
NPV			2,210

The NPV is positive so the project should be accepted.

2 NPV calculation:

Year	Cash flow	Discount factor (8%)	Present value
0	(65,000)	1	(65,000)
1	27,000	$\frac{1}{(1.08)}$	25,000
2	31,000	$\frac{1}{(1.08)^2}$	26,578
3	15,000	$\frac{1}{(1.08)^3}$	11,907
NPV			(1,515)

The NPV is negative so the project should be rejected.

Solutions **2**

1 NPV calculation:

Year	Cash flow	Discount factor (15%)	Present value
0	(556,000)	1	(556,000)
5	56,000	$\frac{1}{(1.15)^5}$	27,842
1 – 5	200,000	$= \frac{1}{0.15}(1 - \frac{1}{1.15^5})$	670,431
NPV			142,273

The NPV is positive so the project should be accepted.

2 NPV calculation:

Year	Cash flow	Discount factor (10%)	Present value
0	(1,616,000)	1	(1,616,000)
4	301,000	$\frac{1}{(1.1)^4}$	205,587
1 – 4	500,000	$= \frac{1}{0.1}(1 - \frac{1}{1.1^4})$	1,584,932
NPV			174,519

The NPV is positive so the project should be accepted.

Solutions **3**

1 NPV at 11% is ₦2,210. A higher rate is needed to produce a negative NPV. (say 15%)

Year	Cash flow	Discount factor at 15%	Present value at 15%
0	(53,000)	1,000	(53,000)
1	17,000	0.870	14,790
2	25,000	0.756	18,900
3	16,000	0.658	10,528
4	12,000	0.572	6,864
NPV			(1,918)

Using

$$IRR = A\% + \left(\frac{NPV_A}{NPV_A - NPV_B}\right) \times (B - A)\%$$

$$IRR = 10\% + \left(\frac{2,210}{2,210 + 1,918}\right) \times 5\%$$

$$IRR = 10\% + \left(\frac{2,210}{4,128}\right) \times 5\%$$

$$IRR = 10\% + 0.535 \times 5\% = 10\% + 2.7\%$$

$$IRR = 12.7\%$$

Solutions **3**

2 NPV at 8% is ₦(1,515). A lower rate is needed to produce a positive NPV. (say 5%)

Year	Cash flow	Discount factor at 5%	Present value at 5%
0	(65,000)	1,000	(65,000)
1	27,000	0.952	25,704
2	31,000	0.907	28,117
3	15,000	0.864	12,960
NPV			1,781

Using

$$IRR = A\% + \left(\frac{NPV_A}{NPV_A - NPV_B}\right) \times (B - A)\%$$

$$IRR = 5\% + \left(\frac{1,781}{1,781 + 1,515}\right) \times 3\%$$

$$IRR = 5\% + \left(\frac{1,781}{3,296}\right) \times 3\%$$

$$IRR = 5\% + 0.540 \times 3\% = 5\% + 1.6\%$$

$$IRR = 6.6\%$$

Solution **4**

	0	1	2	3	4	5
	₦	₦	₦	₦	₦	₦
Initial outlay	(200,000)					
Disposal (₦20k × $(1.05)^5$)						25,526
Revenue						
At today's prices		200,000	200,000	250,000	150,000	100,000
Inflation factor		× 1.07	× 1.07^2	× 1.07^3	× 1.07^4	× 1.07^5
Money cash flows		214,000	228,980	306,261	196,619	140,255
Costs						
At today's prices		100,000	100,000	125,000	75,000	50,000
Inflation factor		× 1.12	× 1.12^2	× 1.12^3	× 1.12^4	× 1.12^5
Money cash flows		112,000	125,440	175,616	118,014	88,117
Net cash flow		102,000	103,540	130,645	78,605	77,664
Discount factors (at 16%)	1.000	0.862	0.743	0.641	0.552	0.476
	(200,000)	87,924	76,930	83,743	43,390	36,968
NPV						128,955

Skills level
Performance management

CHAPTER 27

Replacement theory

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

D	**Decision making**		
	1	**Advanced decision-making and decision-support**	
		G	Evaluate how management can deal with uncertainty in decision-making including the use of simulation, decision-trees, replacement theory, expected values, sensitivity analysis and value of perfect and imperfect information.
	2	**Capital budgeting decisions**	
		C	Evaluate asset replacement decision for mutually exclusive projects with unequal lives.

Exam context

This chapter explains replacement theory.

This relates to situations where a machine is used for a period, then sold and replaced.

The costs associated with acquiring and using a machine includes its purchase price (net of its scrap value) and maintenance costs. As machines and equipment wear out, they need more maintenance and lose second hand value. The total life time cost of a cycle can be expressed as an annual cost (in a number of ways).

Section 1 considers the optimum replacement cycle ignoring time value.

Section 2 considers the optimum replacement cycle taking time value into account. This is done by calculating the equivalent annual cost.

Section 3 looks at a slightly different topic. It considers replacement of components and whether it is cheaper to replace similar components as they fail or on a selective basis or in total periodically.

By the end of this chapter, you should be able to:

- Identify the optimum replacement policy using average annual cost (ignoring time value)
- Identify the optimum replacement policy using equivalent annual cost (taking time value into account)
- Appraise policies to replace components that fail suddenly (individual, selective and group replacement)

1 ASSET REPLACEMENT IGNORING TIME VALUE

Section overview

- Introduction
- Replacing assets that deteriorate over time (ignoring time value)

1.1 Introduction

This chapter explains techniques that may be used to decide whether an asset or part of an asset should be replaced or not.

There are different types of decisions that can be made. This chapter covers:

- When to replace an asset that deteriorates over time:
  - ignoring time value; and
  - taking account of time value;
- When to replace assets that fail suddenly. (The answer to this might sound obvious but the decision is about whether to wait for actual failure or to replace before failure occurs.

1.2 Replacing assets that deteriorate over time (ignoring time value)

An asset replacement decision involves deciding how frequently a non-current asset should be replaced, when it is in regular use, so that when the asset reaches the end of its useful life, it will be replaced by an identical asset.

In other words, this type of decision is about the most appropriate useful economic life of a non-current asset (how frequently it should be replaced).

This is not a one-off decision about whether or not to acquire an asset. Instead it is about deciding when to replace an asset we are currently using with another new asset; and then when the new asset has been used up, replacing it again with an identical asset; and so on in perpetuity.

The approach is to evaluate the cycle of replacing the machine – considering the various options for how long it should be kept before it is replaced.

The decision rule is that the preferred replacement cycle for an asset should be the least-cost replacement cycle. This is the frequency of replacement that minimises the cost.

Example:

A delivery company owns a fleet of lorries.

As a lorry grows older it becomes more expensive to maintain and its second hand value falls.

On the other hand, keeping the asset for longer postpones the need to buy a new asset.

There is a cost trade off.

Replacing the asset every year results in low maintenance costs and high second hand value but requires the purchase of a new asset on an annual basis.

Lengthening the replacement cycle leads to an increase in maintenance costs and a fall in second hand value of the assets but postpones the capital outlay on the purchase of a new asset.

This section explains how to identify the optimum replacement cycle for such assets. The optimum replacement cycle is identified as the cycle that minimises average annual cost.

The average annual cost is calculated by identifying the total cost of a given replacement cycle and dividing that by the length of the replacement cycle.

Formula: Average annual cost

$$\text{Average annual cost} = \frac{\text{Total cumulative cost}}{\text{Length of the cycle}}$$

$$\text{Total cumulative cost} = \text{Total capital cost} + \text{Cumulative maintenance cost}$$

$$\text{Total capital cost} = \text{Purchase price of the asset} - \text{Scrap value of the asset at the end of the cycle}$$

The best way to calculate the average annual costs for a number of cycles is by constructing a table with a row for each cycle length.

Example: Optimum replacement cycle (no time value)

A company is considering its replacement policy for a particular machine.

The machine has purchase cost of ₦15,000 and a maximum useful life of three years.

The following information is also relevant:

Year	Maintenance/running costs of machine	Scrap value if sold at end of year
1	1,000	8,000
2	3,000	5,500
3	5,500	3,000

The optimum replacement cycle is identified as follows:

Cycle length	Capital cost (W1)		Running cost (W2)		Total cycle cost	Average annual cost (total cycle cost÷ cycle length)
1	7,000	+	1,000	=	8,000	8,000
2	9,500	+	4,000	=	13,500	6,750
3	12,000	+	9,500	=	21,500	7,167

Workings

W1 Total capital cost over each cycle

	Purchase price	Scrap proceeds	Total capital cost
1	15,000	8,000	7,000
2	15,000	5,500	9,500
3	15,000	3,000	12,000

W2Total maintenance cost over each cycle

	Annual running costs	Cumulative running costs
1	1,000	1,000
2	3,000	4,000
3	5,500	9,500

Conclusion:

A two-year replacement cycle has the lowest average annual cost.

The asset should be replaced every two years.

Practice question **1**

A company wishes to identify the optimum replacement cycle of a machine.

The machines cost ₦70,000.

The company has estimated annual running costs and second hand value of the machine as follows:

Year	Annual maintenance cost (₦)	Second hand value at the end of the year (₦)
1	9,000	40,000
2	12,000	20,000
3	16,000	12,000
4	21,000	6,000
5	28,000	5,000
6	37,000	4,000
7	47,000	4,000
8	59,000	4,000

Identify the optimum replacement cycle using the average annual cost.

2 ASSET REPLACEMENT TAKING TIME VALUE INTO ACCOUNT

Section overview

- The cash flows to consider
- The equivalent annual cost method

2.1 The cash flows to consider

The cash flows that must be considered when making the asset replacement decision are:

- The capital cost (purchase cost) of the asset
- The maintenance and operating costs of the asset: these will usually increase each year as the asset gets older
- The scrap value or resale value of the asset at the end of its life.

The main problem with evaluating an asset replacement decision is comparing these costs over a similar time frame. For example, the PV of costs of a two-year replacement cycle cannot be directly compared with the PV of costs of a three-year replacement cycle, because whilst the PV of costs of a 2-year cycle might be lower than PV of costs of a 3-year cycle it is for one year less.

A method is needed for comparing the costs of replacement cycles of different lengths. The approach used is to turn the present value of a cycle into an equivalent annual cost. This was covered in an earlier chapter but is repeated here for your convenience.

Equivalent annual costs

An annuity is multiplied by an annuity factor to give the present value of the annuity.

This can work in reverse. If the present value is known it can be divided by the annuity factor to give the annual cash flow for a given period that would give rise to it.

Illustration: Equivalent annual costs

What is the present value of 10,000 per annum from t1 to t5 at 10%?

Time	Cash flow	Discount factor	Present value
1 to 5	₦10,000	3.791	₦37,910

What annual cash flow from t1 to t5 at 10% would give a present value of 37,910?

	₦37,910
Divide by the 5 year, 10% annuity factor	÷3.791
	₦10,000

The above example used the same set of cash flows in each direction. This does not have to be the case.

Illustration: Equivalent annual cost

Time	Cash flow (₦)	Discount factor	Present value (₦)
0	(10,000)	1	(10,000)
1	8,000	0.909	7,272
2	9,000	0.826	7,434
3	12,000	0.751	9,012
			13,716

This can be turned into an equivalent annual cost by dividing the present value by the three year annuity factor.

Present value	₦13,716
Divide by the 3 year, 10% annuity factor	÷3.486
Equivalent annual cost	₦3,935

Proof (with a small rounding difference)

Time	Cash flow	Discount factor	Present value
1 to 3	₦3,934.6	3.486	₦13,717

Thus, receiving ₦3,934.6 per annum for three years is the equivalent of spending ₦10,000 at t0 and receiving ₦8,000 at t1, ₦9,000 at t2 and ₦12,000 at t3.

2.2 The equivalent annual cost method

The equivalent annual cost method of calculating the most cost-effective replacement cycle for assets is as follows:

For each choice of replacement cycle, the PV of cost is calculated over one full replacement cycle, with the asset purchased in year 0 and disposed of at the end of the life cycle.

This PV of cost is then converted into an equivalent annual cost or annuity. The equivalent annual cost is calculated by dividing the PV of cost of the life cycle by the annuity factor for the cost of capital, for the number of years in the life cycle.

Formula: Equivalent annual cost

$$\text{Equivalent annual cost for replacement every n years} = \frac{\text{Net PV of costs over one replacement cycle}}{\text{Annuity factor for Years 1 - n}}$$

The replacement cycle with the lowest equivalent annual cost is selected as the least-cost replacement cycle.

Example: Equivalent annual cost

Nigeria Technics Plc is considering its replacement policy for a particular machine.

The machine has purchase cost of ₦17,000 and a maximum useful life of three years.

Year	Maintenance/running costs of machine	Scrap value if sold at end of year
1	1,900	8,000
2	2,400	5,500
3	3,750	4,000

Nigeria Tech Plc 's cost of capital is 10%.

The optimum replacement cycle is identified as follows.

Replace every year

T		Cash flow	Discount factor (10%)	Present value
0	Purchase price	(17,000)	1.000	(17,000)
1	Maintenance costs	(1,900)	0.909	(1,727)
1	Resale value	8,000	0.909	7,272
	PV of costs of one cycle			(11,455)
	Annuity factor for one year			÷0.909
	Equivalent annual cost			(12,602)

Replace every two years

T		Cash flow	Discount factor (10%)	Present value
0	Purchase price	(17,000)	1.000	(17,000)
1	Maintenance costs	(1,900)	0.909	(1,727)
2	Maintenance costs	(2,400)	0.826	(1,982)
2	Resale value	5,500	0.826	4,543
	PV of costs of one cycle			(16,166)
	Annuity factor for one year			÷1.736
	Equivalent annual cost			(9,312)

Example (continued): Equivalent annual cost

Replace every three years

T		Cash flow	Discount factor (10%)	Present value
0	Purchase price	(17,000)	1.000	(17,000)
1	Maintenance costs	(1,900)	0.909	(1,727)
2	Maintenance costs	(2,400)	0.826	(1,982)
3	Maintenance costs	(3,750)	0.751	(2,816)
3	Resale value	4,000	0.751	3,004
	PV of costs of one cycle			(20,521)
	Annuity factor for one year			÷2.487
	Equivalent annual cost			(8,251)

Conclusion:

A three-year replacement cycle has the lowest equivalent annual cost. The asset should be replaced every three years.

Year	Maintenance/running costs of machine	Scrap value if sold at end of year
1	4,000	15,000
2	5,000	10,000
3	6,500	6,000
4	8,000	1,000

Long’s cost of capital is 12%

3 REPLACING COMPONENTS

Section overview

- Introduction
- Possible policies
- Individual replacement of components
- Group replacement of components
- Selective replacement of components

3.1 Introduction

The previous sections were concerned with assets that deteriorate over time. Such assets can of course fail suddenly but are not expected to do so and it would be considered as an unusual event if they did.

Some types of assets are expected to fail suddenly. In general, this applies to components of other assets.

Components would have varying life spans but often, a company would have a great deal of historical experience about the rate of failure. This means that knowledge of the probabilities associated with different life spans would be available.

Question types

Questions might involve identifying the cost of a chosen policy. This would involve identifying all costs in a period that result from the chosen policy.

Often questions concern choosing between different policies. Different policies will result in different costs. The policy that has the lower cost should be chosen.

3.2 Possible policies

Individual replacement

Under this policy, an item is replaced immediately when it fails (and only if it fails).

The machine must be stopped in order to replace the component. Each stoppage will cost money (e.g. loss of production, cost of the repair). However, the company only needs to replace components that have failed.

Group replacement

Under this policy, every item is replaced during a single stoppage whether it has failed or not.

This involves less down time for the machine (thus, reducing costs associated with the down time) but involves buying more components. Also note that the calculations might be complicated by the need to replace components that fail between each group replacement.

Selective replacement

The relevant scenario is that a machine or production line contains a number of similar components where failure of a component does not necessarily stop the machine from working. (This is the concept of redundancy. Redundancy is the duplication of critical components of a system with the intention of increasing reliability of the system. For example, redundancy is built into many aspects of aircraft design where failure of a component could be disastrous).

Only items that have failed are replaced but this occurs when a machine can operate until a certain number of items have failed and that number has been reached.

3.3 Individual replacement of components

The costs of this approach include the cost of the failed item. This is the cost of item but also might include an installation cost or an inspection cost per item.

There might also be a cost associated with stopping the machine. This in turn might include costs associated with lost production and the cost of gaining access and so forth.

Formula: Cost of individual replacement policy

$$\text{Total cost of replacement in the period} = \text{Average number replaced in the period} \times \text{Cost of replacing one item}$$

$$\text{Average number replaced in the period} = \frac{\text{Total number of items used per period}}{\text{Average life span}}$$

The average life span might need to be calculated as an expected value.

Example: Individual replacement.

A company runs a production line that contains 500 identical components. These fail on a regular basis according to the following probability distribution.

Life (months)	Probability of failure
1	0.2
2	0.5
3	0.3

The cost of replacing a single component is ₦75

The cost of replacing failed components can be calculated as follows:

Working 1: Average life span of a component

Life in months (X)	Probability of failure (P)	PX
1	0.2	0.2
2	0.5	1.0
3	0.3	.9
Expected life span (months)		2.1

Working 2: Average number replaced in the period

Average number replaced in the period = $\frac{\text{Total number of items used per period}}{\text{Average life span}}$

= $\frac{\text{500 components}}{\text{2.1 months (W1)}}$

= 238 components per month

Working 3: The average monthly cost is calculated as follows:

Total cost of replacement in the period	=	Average number replaced in the period (W2)	×	Cost of replacing one item
	=	238	×	₦75
	=	₦17,850		

Practice question **3**

A company runs a production line that contains 600 identical components. These fail on a regular basis according to the following probability distribution:

Life (months)	Probability of failure
1	0.1
2	0.3
3	0.35
4	0.2
5	0.05

The cost of replacing a single component is ₦50.

Calculate the monthly cost of replacing components as they fail.

3.4 Group replacement of components

This involves periodically replacing every component whether or not it has failed. The period chosen will be that that minimises the cost.

The calculations are not as straightforward as at first might be thought. This is because components that fail in the periods between the complete replacements may also have to be replaced.

Example: Group replacement

A company runs a production line that contains 500 identical components. These fail on a regular basis according to the following probability distribution.

Life (months)	Probability of failure
1	0.2
2	0.5
3	0.3

The cost of replacing a single component during the group replacement is ₦25 but the cost of replacing a failed component between replacements is ₦50.

Costs associated with different replacement cycles are as follows:

Replace components every month

	Components	Unit cost	₦
Full replacement	500	₦25	12,500
Failures in month 1			
20% × 500	100	₦50	5,000
			17,500

Replace components every 2 months

	Components	Unit cost	₦
Full replacement	500	₦25	12,500
Failures in month 1			
20% × 500	100	₦50	5,000
Failures in month 2			
50% × 500	250		
20% × 100	20		
	270	₦50	13,500
			31,000

Tutorial note: The 100 units replaced in month 1 are themselves one moth old in month 2. The 100 units is subject to the same failure rate as the units bought at the start of the cycle

Example (continued): Group replacement.

Replace components every 3 months

	Components	Unit cost	₦
Full replacement	500	₦25	12,500
Failures in month 1			
20% × 500	100	₦50	5,000
Failures in month 2			
50% × 500	250		
20% × 100	20		
	270	₦50	13,500
Failures in month 3			
30% × 500	150		
50% × 100	50		
20% × 270	54		
	254	₦50	12,700
			43,700

The costs for each period must be put onto a common base for comparison

Total cost	17,500	31,000	43,700
Number of months	1	2	3
Average monthly cost	17,500	15,500	14,567

Conclusion: The company should operate a three month cycle.

In the above example, the costs associated with each cycle have been worked in full to better explain the answer. However, there is a shorter way of setting this out using the costs associated with a one-month cycle as a foundation.

The cost of replacing items in each subsequent month can be added to the previous month total to arrive at the total for that month's cycle.

The solution to the previous example would then be as follows:

Example: Group replacement (alternative presentation of answer)

Costs associated with different replacement cycles are as follows:

Replace components every month

	Components	Unit cost	₦
Full replacement	500	₦25	12,500
Failures in month 1			
20% × 500	100	₦50	5,000
Total cost for one month cycle			17,500

Replace components every 2 months

Failures in month 2	Components	Unit cost	
50% × 500	250		
20% × 100	20		
	270	₦50	13,500
Total cost for two month cycle			31,000

Replace components every 3 months

Failures in month 3	Components	Unit cost	
30% × 500	150		
50% × 100	50		
20% × 270	54		
	254	₦50	12,700
Total cost for three month cycle			43,700

The costs for each period must be put onto a common base for comparison

Total cost	17,500	31,000	43,700
Number of months	1	2	3
Average monthly cost	17,500	15,500	14,567

Conclusion: The company should operate a three-month cycle.

Practice question **4**

A company runs a production line that contains 798 identical components. These fail on a regular basis according to the following probability distribution:

Life (months)	Probability of failure
1	0.1
2	0.3
3	0.35
4	0.2
5	0.05

The cost of replacing a single component is ₦60. However, if all components are replaced together the cost falls to 14 per component

Calculate the monthly cost of a group replacement policy for 1, 2, 3, 4 and 5-month replacement cycles.

3.5 Selective replacement of components

As explained earlier, this sort of problem relates to a scenario where redundancy has been built into a system. In other words it incorporates a number of similar components arranged such that the system can continue to operate when some of the components fail. However, a point is reached where the number of failed components is such that they must be replaced. The choice then is whether to replace only those components that have failed or to replace all components whether they have failed or not. The purpose in replacing all components is to delay the time until the next change is necessary.

Example: Selective or group replacement.

A company operates a machine that contains 500 identical components which fail on a regular basis.

The machine can continue to operate until 20% of the components fail. When this point is reached the machine must be stopped to replace the components.

The following costs have been estimated:

Stripping down the machine to replace components	**₦2,500**
Cost of a single component	**₦100**
Cost of inspecting an individual component to see if it has failed	**₦50**

The company currently has a policy of waiting until the machine stops working and then inspecting components in order to see which need to be replaced. Only those components that have failed are replaced.

Under the current policy each machine breaks down on average 3 times every month.

The company is considering a new policy under which it will stop the machine twice a month and replace all components. This will save on inspection costs but will involve replacing good components as well as failed ones.

Is this policy worthwhile?

Current policy (selective replacement)

Cost of stripping down the machine		2,500
Inspection cost	500 units × ₦50 per unit	25,000
Cost of units replaced	100 units × ₦100 per unit	10,000
Cost per breakdown		37,500
Number of breakdowns per month		3
Monthly cost		112,500

New policy (group replacement)

Cost of stripping down the machine		2,500
Inspection cost		nil
Cost of units replaced	500 units × ₦100 per unit	50,000
Cost per breakdown		52,500
Number of breakdowns per month		2
Monthly cost		105,000

Conclusion: The new policy should be adopted.

4 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Identify the optimum replacement policy using average annual cost (ignoring time value)
- Identify the optimum replacement policy using equivalent annual cost (taking time value into account)
- Appraise policies to replace components that fail suddenly (individual, selective and group replacement)

SOLUTIONS TO PRACTICE QUESTIONS

Solution **1**

The optimum replacement cycle is identified as follows:

Cycle length	Capital cost (W1)		Running cost (W2)		Total cycle cost	Average annual cost (total cycle cost÷ cycle length)
1	30,000	+	9,000	=	39,000	39,000
2	50,000	+	21,000	=	71,000	35,500
3	58,000	+	37,000	=	95,000	31,667
4	64,000	+	58,000	=	122,000	30,500
5	65,000	+	86,000	=	151,000	30,200
6	66,000	+	123,000	=	189,000	31,500
7	66,000	+	170,000	=	236,000	33,714
8	66,000	+	229,000	=	295,000	36,875

Workings

W1 Total capital cost over each cycle

Year	Purchase price	Scrap proceeds	Total capital cost
1	70,000	40,000	30,000
2	70,000	20,000	50,000
3	70,000	12,000	58,000
4	70,000	6,000	64,000
5	70,000	5,000	65,000
6	70,000	4,000	66,000
7	70,000	4,000	66,000
8	70,000	4,000	66,000

W2 Total maintenance cost over each cycle

Year	Annual running costs	Cumulative running costs
1	9,000	9,000
2	12,000	21,000
3	16,000	37,000
4	21,000	58,000
5	28,000	86,000
6	37,000	123,000
7	47,000	170,000
8	59,000	229,000

Solution (continued) **1**

Conclusion:

A five-year replacement cycle has the lowest average annual cost.

The asset should be replaced every five years.

Solution **2**

Replace every year

T		Cash flow	Discount factor (12%)	Present value
0	Purchase price	(30,000)	1.000	(30,000)
1	Maintenance costs	(4,000)	0.893	(3,572)
1	Resale value	15,000	0.893	13,395
	PV of costs of one cycle			(20,177)
	Annuity factor for one year			÷0.893
	Equivalent annual cost			(22,595)

Replace every two years

T		Cash flow	Discount factor (12%)	Present value
0	Purchase price	(30,000)	1.000	(30,000)
1	Maintenance costs	(4,000)	0.893	(3,572)
2	Maintenance costs	(5,000)	0.797	(3,985)
2	Resale value	10,000	0.797	7,970
	PV of costs of one cycle			(29,587)
	Annuity factor for one year			÷1.690
	Equivalent annual cost			(17,507)

Replace every three years

T		Cash flow	Discount factor (12%)	Present value
0	Purchase price	(30,000)	1.000	(30,000)
1	Maintenance costs	(4,000)	0.893	(3,572)
2	Maintenance costs	(5,000)	0.797	(3,985)
3	Maintenance costs	(6,500)	0.712	(4,628)
3	Resale value	6,000	0.712	4,272
	PV of costs of one cycle			(37,913)
	Annuity factor for one year			÷2.402
	Equivalent annual cost			(15,784)

Solution (continued) **2**

Replace every four years

T		Cash flow	Discount factor (12%)	Present value
0	Purchase price	(30,000)	1.000	(30,000)
1	Maintenance costs	(4,000)	0.893	(3,572)
2	Maintenance costs	(5,000)	0.797	(3,985)
3	Maintenance costs	(6,500)	0.712	(4,628)
4	Maintenance costs	(8,000)	0.636	(5,088)
4	Resale value	1,000	0.636	636
	PV of costs of one cycle			(46,637)
	Annuity factor for one year			÷3.037
	Equivalent annual cost			(15,536)

Conclusion:

A four-year replacement cycle has the lowest equivalent annual cost.

The asset should be replaced every four years.

Solution **3**

Working 1: Average life span of a component

Life in months (X)	Probability of failure (P)	PX
1	0.1	0.1
2	0.3	0.6
3	0.35	1.05
4	0.2	0.8
5	0.05	0.25
Expected life span (months)		2.8

Working 2: Average number replaced in the period

$$\text{Average number replaced in the period} = \frac{\text{Total number of items used per period}}{\text{Average life span}}$$

$$= \frac{\text{600 components}}{\text{2.8 months (W1)}}$$

= = 214.3 components per month

Working 3: The average monthly cost is calculated as follows:

Total cost of replacement in the period	=	Average number replaced in the period (W2)	×	Cost of replacing one item
	=	214.3	×	₦50
	=	₦10,715		

Solution **4**

Replace components every month

	Components	Unit cost	₦
Full replacement	798	₦14	11,172
Failures in month 1			
10% × 798	80	₦60	4,800
Total cost of group replacement every month			15,972

Replace components every 2 months

Failures in month 2	Components	Unit cost	
30% × 798	239		
10% × 80	8		
	247	₦60	14,820
Total cost of group replacement every two months			30,792

Replace components every 3 months

Failures in month 3	Components	Unit cost	
35% × 798	279		
30% × 80	24		
10% × 247	25		
	328	₦60	19,680
			50,472

Replace components every 4 months

Failures in month 3	Components	Unit cost	
20% × 798	160		
35% × 80	28		
30% × 247	74		
10% × 328	33		
	295	₦60	17,700
			68,172

Replace components every 5 months

Failures in month 3	Components	Unit cost	
5% × 798	40		
20% × 80	16		
35% × 247	86		
30% ×328	98		
10% × 295	30		
	270	₦60	16,200
			84,372

Solution (continued) **4**

The costs for each period must be put onto a common base for comparison

Total cost	15,972	30,792	50,472	68,172	84,372
Number of months	1	2	3	4	5
Average monthly cost	15,972	15,396	16,824	17,043	16,874

Conclusion: The company should operate a two-month cycle.

Skills level
Performance management

CHAPTER 28

Strategic models and performance management

Contents

INTRODUCTION

Aim

Performance management develops and deepens candidates' capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Candidates are expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

The detailed syllabus includes the following:

E	**Strategic performance measurement**		
	1	Analyse and evaluate business objectives and strategies using techniques such as:	
		a	C-analysis;
		b	Five forces analysis;
		c	The Boston Consulting Group Model;
		d	Value chain analysis;
		e	Ansoff's matrix;
		f	Benchmarking; and
		g	SWOT analysis.

Exam context

This paper is about performance management and not just about performance measurement. Measurement is a component of management. In this paper you are required to be able to review measures in place and suggest alternatives when weaknesses are identified. This review would be in the context of the strategy of the organisation and how the performance management system was working to help achieve the corporate objectives.

This chapter explains various models that can be used in the strategic planning process.

By the end of this chapter, you should be able to:

- Explain, perform and interpret C analysis
- Explain and apply Porter's five forces model to identify industry attractiveness
- Explain and apply the Boston Consulting Group model to identify categories of product (business) in a company's portfolio
- Explain and interpret value chain analysis
- Use Ansoff's grid to identify possible strategic directions
- Explain and apply benchmarking to compare performance against information provided (for example, about a competitor)
- Construct and interpret a SWOT analysis

1 INTRODUCTION TO STRATEGIC PLANNING AND CONTROL

Section overview

- Levels of strategic planning
- Definition of strategic planning and control
- Advantages of formal strategic planning
- Overview of a formal strategic planning process
- Strategic analysis
- Corporate appraisal
- Strategic choice
- Evaluation of strategic options
- Other issues

1.1 Levels of strategic planning

Planning is a hierarchical activity, linking strategic planning at the top with detailed operational planning at the bottom. Strategic plans set a framework and guidelines within which more detailed plans, and shorter-term planning decisions, can be made.

R N Anthony identified three levels of planning: within an organisation:

- **Strategic planning**. This involves identifying the objectives of the entity, and plans for achieving those objectives, mostly over the longer term. Strategic plans include corporate strategy plans, business strategy plans and functional strategy plans.
- **Tactical planning**. These are shorter-term plans for achieving medium-term objectives. An example of tactical planning is the annual budget. Budgets and other tactical plans can be seen as steps towards the achievement of longer-term strategic objectives.
- **Operational planning**. This is detailed planning of activities, often at a supervisor level or junior management level, for the achievement of short-term goals and targets. For example, a supervisor might divide the workload between several employees in order to complete all the work before the end of the day.

1.2 Definition of strategic planning and control

'Strategic planning and control' within an entity is the continuous process of:

- identifying the goals and objectives of the entity
- planning strategies that will enable these goals and objectives to be achieved
- setting targets for each strategic objective (performance targets)
- converting strategies into shorter-term operational plans
- implementing the strategy
- monitoring actual performance (performance measurement and review)

- taking control measures where appropriate when actual performance is below the target.

Other aspects of strategic planning and control are:

- re-assessing plans and strategies when circumstances in the business environment change
- where necessary, changing strategies and plans.

1.3 Advantages of formal strategic planning

Companies often have a formal strategic planning process, because a formal system of planning:

- clarifies objectives
- helps management to make strategic decisions. Strategic planning forces managers to think about the future: companies are unlikely to survive unless they plan ahead
- establishes targets for achievement
- co-ordinates objectives and targets throughout the organisation, from the mission statement and strategic objectives at the top of a hierarchy of objectives, down to operational targets
- provides a system for checking progress towards the objectives.

However, planning must also be flexible. Plans and targets might need to change in response to changes in the business environment, for example, a new initiative by a rival company.

Changes in strategic plans

Strategic plans often cover a period of several years, typically five years or longer. They are prepared on the basis of the best information available at the time, using assumptions about the nature of the business environment – competitive conditions, market conditions, available technology, the economic, social and political climate, and so on.

However, the business environment can change very quickly, in unexpected ways. Changes can create new threats to a company, or they can create new business opportunities. Whenever changes occur, a company should be able to respond – taking measures to deal with new threats, or to exploit new opportunities.

The response of a company to changes in its environment could mean having to develop new strategies and abandon old ones. When changes are made, the original strategic plan will no longer be entirely valid, although large parts of it might be unaffected.

Strategic planning in practice is therefore often a mixture of:

- formal planning, and
- developing new strategies and making new plans whenever significant changes occur in its business environment.

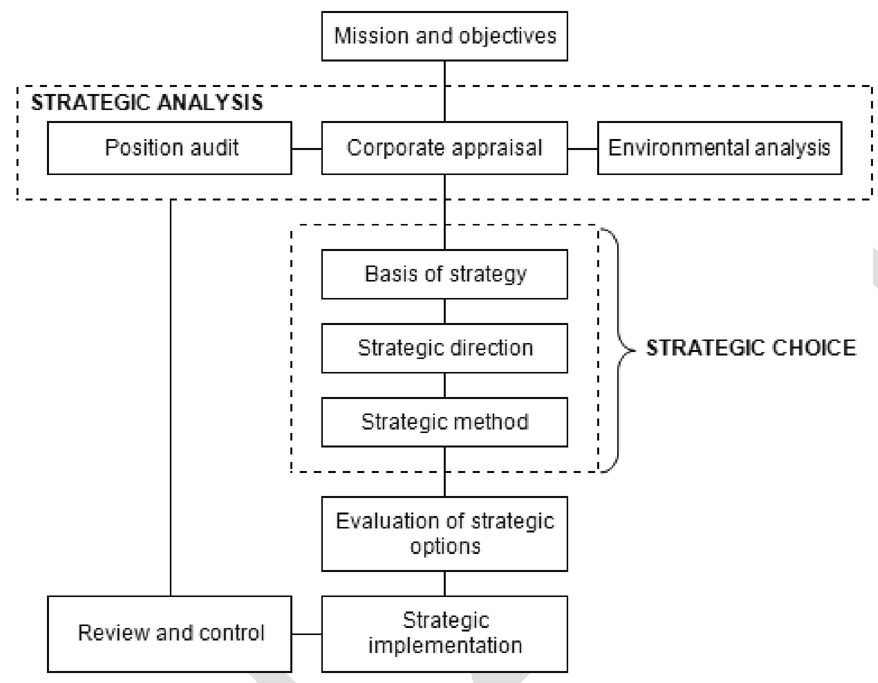
Responding to unexpected changes by doing something that is not in the formal plan is sometimes called ‘freewheeling opportunism’. It means making unplanned decisions, to take advantages of opportunities as they arise, or to deal with unexpected threats.

1.4 Overview of a formal strategic process

Different methods and approaches may be used to develop strategic plans.

A basic approach to strategic planning is shown in the following diagram.

Illustration: Overview of a formal strategic process



Mission and objectives

The entity exists for a purpose, which may be expressed formally in a mission statement.

The entity must develop clear objectives, such as the maximisation of shareholder wealth. These objectives should be consistent with the mission statement. Targets can be established for the achievement of objectives within the planning period.

Objectives should take into account the interest and power of stakeholders. Stakeholder mapping is a useful tool in this regard.

1.5 Strategic analysis

Environmental analysis

Environmental analysis involves an analysis of developments outside the organisation that are already affecting the organisation or could affect the organisation in the future. These are external factors that might affect the achievement of objectives and strategy selection.

An external analysis might consider:

- the political situation in each country where it has operating subsidiaries
- changes in the law, and how these affect the organisation
- changes in economic conditions

- social factors and cultural factors, such as an increasing average age in the population
- technology changes: the development of the internet and e-commerce, for example, have had enormous consequences for business within the past few years
- the competitive environment, such as the entry of a new competitor into the market, or the 'globalisation' of the market.

An external analysis should identify opportunities and threats that face the organisation. Strategies might be developed to exploit opportunities or take counter-measures to deal with threats.

Models that might be used include:

- PESTEL analysis; and
- Porter's 5 forces;

These are covered in more detail later.

Position audit

Internal analysis looks at the strengths and weaknesses within the organisation – its products, existing customers, management, employees, technical skills and 'know-how', its operational systems and procedures, its reputation for quality, the quality of its suppliers, its liquidity and cash flows, and so on.

Strategies should seek to make full use of any strengths within the entity and to reduce or remove significant weaknesses.

Models that might be used include:

- Ms (Men, Management, Money, Make-up, Machinery, Methods, Markets, Materials, Management information);
- Financial analysis;
- Benchmarking;
- Product life cycle;
- Boston consulting grid;
- Value chain analysis;

Some of these are covered in more detail later.

1.6 Corporate appraisal

SWOT analysis

The mission statement and objectives of the entity, together with the results from the environmental analysis and position audit, should lead on to a formal appraisal of strategy and what the entity might be capable of achieving.

SWOT analysis is the analysis of the strengths and weaknesses of an organisation, and the opportunities and threats in its environment. This method of strategic analysis is often used by organisations as a starting point for strategic planning.

Strategic management accounting can assist with SWOT analysis by trying to put costs or benefits to particular strengths, weaknesses, opportunities and threats, so that strategic managers are able to assess their importance.

SWOT analysis is explained in more detail later.

Gap analysis

A strategic plan should set out the ways in which an organisation intends to achieve its objectives. One way of doing this is to prepare a forecast of what is likely to happen if the company carries on with its current plans and policies, and does not take any new strategic initiatives.

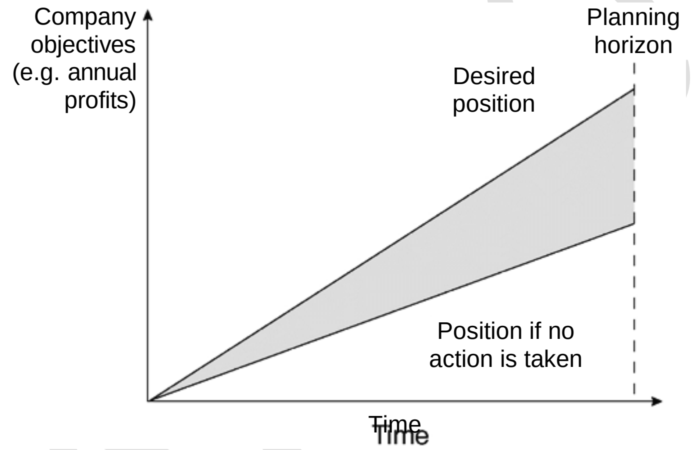
Gap analysis involves:

- identifying the corporate objectives for the organisation, and what strategic management wants the organisation to achieve each year over the planning period
- comparing these strategic targets with the expected actual results, if there are no changes in strategy and no new planning initiatives.

The gap is the difference between these two and is known as is a planning gap.

(Gap analysis is sometimes described as an analysis of the difference between 'Where we are' and 'Where we want to be'.)

Illustration: Gap analysis



Strategies should be developed to close the gap, so that expected performance is in line with the strategic aims and objectives.

1.7 Strategic choice

There are choices to made in three areas

Basis of strategy

This is about how to compete. The work of Michael Porter is influential in this area.

According to Porter, a successful competitive strategy must be based on either:

- cost leadership, or
- differentiation.

Cost leadership means becoming the lowest-cost producer in the market. A company that can make products or provide services at a lower cost than competitors will succeed, by selling at lower prices and winning the biggest share of the market.

Differentiation means making products or services that are considered by customers to be different from those of competitors, and because they are different they are better. A company that is not the least-cost producer can therefore succeed by offering product or service that customers will pay a higher price (than the least-cost producer's price) to obtain.

Either of these strategies might be pursued with a broad focus or in a niche market.

Strategic direction

This concerns which products should be sold to which markets. A useful model here is Ansoff's Grid which is covered in more detail later. It identifies four possible alternatives:

- Sell existing products in existing markets – **Market penetration strategy**.
- Sell existing products in new markets – **Market development strategy**
- Sell new products in existing markets – **Product development strategy**.
- Sell new products in new markets – **Diversification strategy**.

Strategic method

This concerns the question of how to grow? Growth can be achieved through:

- Internal growth (also called organic growth)
- Acquisitions and mergers
- Joint ventures or strategic alliances

1.8 Evaluation of strategic options

Strategies should be evaluated to decide whether they might be appropriate. Johnson and Scholes have suggested that strategies should be assessed for:

- suitability;
- feasibility;
- acceptability

Suitability

A strategy must be suitable for achieving the strategic aims and requirements of the company. This must be assessed in terms of resources and competences.

A strategy must enable the company to take advantage of its core competences and unique resources, in order to gain competitive advantage

Suitability relates to the strategic logic and strategic fit of the strategy

The strategy must fit the company's operational circumstances and strategic position.

Key questions include does the strategy:

- Exploit company strengths and distinctive competences?
- Rectify company weaknesses?
- Neutralise or deflect environmental threats?
- Help the firm to seize opportunities?

- Satisfy the goals of the organisation?
- Fill the gap identified by gap analysis?
- Generate/maintain competitive advantage?

Feasibility

Questions that might be asked to assess feasibility are:

- Can we afford it?
- Will we have the labour skills needed?
- Can we achieve the necessary product quality?
- Can we produce at the cost that will be necessary?
- Do we have the marketing skills needed?
- Can we obtain the raw materials needed?

Acceptability

A strategy must be acceptable to the key stakeholders affected by it. A strategy is inappropriate if it is unacceptable to any key stakeholders

1.9 Other issues

Strategic implementation

The selected strategies should then be implemented.

The implementation of strategies should be monitored. Changes and adjustments should be made where these become necessary.

Areas of importance here are change management and project management. These are covered in more detail later

Review and control

This is a key area. An entity will have management information systems in place to monitor the progress of the business. These are particularly important to the introduction of a new strategy where timing and achievement of progress points might be vital to its success. This is covered in more detail later.

2 MODELS FOR ENVIRONMENTAL ANALYSIS

Section overview

- The nature of environmental analysis
- The purpose of environmental analysis
- Two models for environmental analysis

2.1 The nature of environmental analysis

A business entity cannot exist in isolation from its environment. It inter-relates with its environment, and its survival and strategic success depend on how well it responds to the threats and opportunities that the environment provides.

An entity's environment is anything that is not a part of the entity itself. For a business organisation, the environment includes customers, potential customers, markets, competitors, suppliers, governments and potential sources of new employees. It also includes the social, political and economic environment in which the entity exists and operates.

The term '**macro-environment**' is used to mean general factors in the business environment of an entity, rather than specific customers, suppliers and competitors.

Environmental influences on an organisation vary with the size of the organisation, and the industry and the countries in which it operates.

The importance of environmental factors for strategic management arises because:

- organisations operate within their environment and interact with it
- changes in the environment can be large and significant – and continually happening
- future changes can be very difficult to predict.

2.2 The purpose of environmental analysis

Environmental analysis is a part of the process of assessing strategic position. In order to make strategic choices about the future, the management of an entity need to understand:

- the factors in the environment that have a significant effect on the entity and what it does
- the key drivers of change: these are the factors in the environment that will have the greatest effect on the entity, and force the entity to change its strategies in order to survive and succeed
- the difference in impact that key drivers of change in the environment will have on different industries or different markets, or how changes in the environment might affect one particular entity more or less than other entities.

It is also important to consider the **future impact** of factors in the environment. The future impact might be different from the impact that they have had in the past. Some factors might grow in significance; others might become less significant.

Environmental analysis is the process of:

- studying the environment in which an entity operates
- identifying significant factors in the environment, particularly those that will be significant in the future.

The purpose of the analysis is to assess the environment, to **analyse the position of an entity in relation to its environment** and to judge how the entity's strategies should be developed to take advantage of opportunities and deal with any potential threats. It is a first step towards formulating a business strategy.

2.3 Two models for environmental analysis

In your examination, you may be required to carry out an environmental analysis. You might be required to use any 'model' of your choice. Alternatively you might be asked specifically to use PESTEL analysis or Porter's Diamond.

- The PESTEL model is used to identify significant factors in the macro-environment of an entity.
- Porter's Diamond model is used to analyse reasons why entities in particular countries, or regions within a country, appear to have a significant competitive advantage over similar entities in the same industry, but operating in other countries or other regions.

3 PESTEL ANALYSIS

Section overview

- The nature of PESTEL analysis
- Social and cultural environment
- Legal environment
- Economic environment
- Political environment
- Technological environment
- Ecological influences
- Limitations of PESTEL analysis

3.1 The nature of PESTEL analysis

PESTEL analysis is a structured approach to analysing the external environment of an entity. The influences (current influences and possible future influences) of the environment on the entity are grouped into categories. For each category of environmental influence, the main influences are identified.

There are six categories of environmental influence:

- P – Political environment
- E – Economic environment
- S – Social and cultural environment
- T – Technological environment
- E – Ecological influences
- L – Legal environment

The purpose of dividing environmental influences into categories is simply to make it easier to organise the environmental analysis and ensure that some key influences are not over-looked. It provides a **useful framework** for analysis.

You might also see reference to SLEPT analysis and PEST analysis. These are similar to PESTEL analysis in concept, but use a smaller number of environmental categories.

- SLEPT analysis uses the same categories of environmental influence as PESTEL analysis, without 'Ecological influences'.
- PEST analysis is the same as SLEPT analysis, but includes 'Political influences' and 'Legal environment' in the same category.

3.2 Social and cultural environment

An entity is affected by social and cultural influences in the countries or regions in which it operates, and by social customs and attitudes. Some influences are more significant than others.

Factors in the social and cultural environment include the following:

- The values, attitudes and beliefs of customers, employees and the general public.

- Patterns of work and leisure, such as the length of the working week and popular views about what to do during leisure time
- The ethnic structure of society
- The influence of religion and religious attitudes in society
- The relative proportions of different age groups in society.

3.3 Legal environment

The legal environment consists of the laws and regulations affecting an entity, and the possibility of major new laws or regulations in the future.

Laws and regulations vary between different countries, although international regulation is accepted in certain areas of commercial activity, such as banking.

Strategic decisions by an entity might be affected by legal considerations. For example:

- an international company might locate some operations, for tax reasons, in a country with a favourable tax system
- decisions to relocate operations from one country to another could be affected by the differences in employment law in the two countries, or by new employment legislation
- in many industries, companies are faced with environmental legislation or health and safety legislation, affecting the ways in which they operate, as well as the design of the products they make and sell.

3.4 Economic environment

The economic environment consists of the economic influences on an entity and the effect of possible changes in economic factors on future business prospects. Factors in the economic environment include:

- the rate of growth in the economy
- the rate of inflation
- the level of interest rates, and whether interest rates may go up or fall
- foreign exchange rates, and whether particular currencies are likely to get weaker or stronger
- unemployment levels and the availability of skilled or unskilled workers
- government tax rates and government subsidies to industry
- the existence or non-existence of free trade between countries, and whether trade barriers may be removed
- the existence of trading blocs of countries, such as the European Community, Economic Community of West African States (ECOWAS), etc.

Economic factors could affect a decision by a company about where to invest. Tax incentives, the availability of skilled labour, a good transport infrastructure, a stable currency and other factors can all influence strategic choices.

3.5 Political environment

The political environment consists of political factors that can have a strong influence on business entities and other organisations.

Investment decisions by companies will be influenced by factors such as:

- the stability of the political system in particular countries
- the threat of government action to nationalise the industry and seize ownership from private business
- wars and civil unrest
- the threat of terrorist activity.

Political considerations are particularly important for business entities operating in countries with an unstable political regime, or a dictatorship.

3.6 Technological environment

The technological environment consists of the science and technology available to an organisation (and its competitors), and changes and developments in science and technology.

Some aspects of technology and technological change affect virtually all organisations. Developments in IT and computer technology, including the Internet, are the most obvious example. Business entities that do not respond to changes in IT and computerisation risk losing their share of the market to competitors.

However, technological change might also affect particular industries. Scientific developments in food and drugs, for example, are having a continual impact on companies in these industries.

For strategic planning, companies need to be aware of current technological changes and the possible nature of changes in the future. Technology could have an important influence, for example, on investment decisions in research and development, and investment in new technology.

3.7 Ecological influences

For business entities in some industries, environmental factors have an important influence on strategic planning and decision-making. They are particularly important for industries that are:

- subject to strict environmental legislation, or the risk of stricter legislation in the future (for example, legislation to cut levels of atmospheric pollution)
- faced with the risk that their sources of raw materials will be used up (for example, parts of the fishing industry and timber production industry)
- at the leading edge of technological research, such as producers of genetically modified foods.

In some countries, companies have seen a commercial advantage in presenting themselves as ‘environment-friendly’, by improving their reputation with the general public. Several companies have adopted a policy of becoming ‘carbon neutral’ so that they remove as much carbon dioxide from the atmosphere as they add to carbon dioxide with emissions from their operating activities. (It was reported in the UK in 2007 that the demand from UK companies to acquire energy from renewable energy sources was far in excess of the capacity of the energy companies to supply energy from those sources.)

Major oil companies are investing in the development of energy from renewable energy sources, such as the sea and wind.

3.8 Limitations of PESTEL analysis

PESTEL analysis is a useful framework for identifying environmental influences on an entity. However, there are limitations to the technique.

- It is easier to use PESTEL analysis to identify environmental influences in the past and present. It is not so easy to identify the environmental influences that will have the biggest influence in the future.
- It is a method of identifying environmental influences, by providing a framework for analysis. It does not provide an assessment of environmental influences. It is used for qualitative analysis, but not for quantification. A manager using PESTEL analysis might need to use his (subjective) judgement to decide which environmental factors are more important than others.

4 FIVE FORCES MODEL

Section overview

- Competitive strength and the five forces
- Existing competitors and competitive rivalry
- Threat from new entrants
- Bargaining power of suppliers
- Bargaining power of customers
- Threat from substitute products

4.1 Competitive strength and the five forces

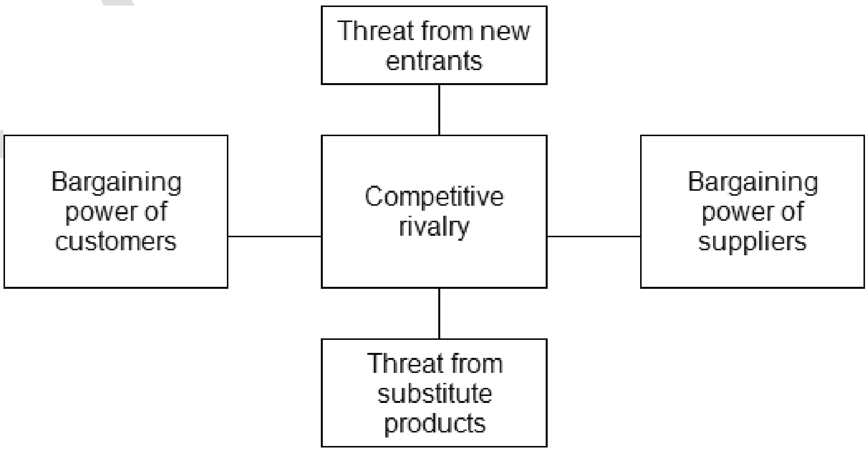
Michael Porter (in *Competitive Strategy*) developed a model for analysing the competitive nature of markets and the competitive position of companies. It is also a model for assessing the problems that a company faces in establishing a strong competitive position in a market.

The model should be used to analyse a 'strategic business unit', rather than a company as a whole. A strategic business unit (or SBU) is a part of a company's operations for which there is a separate and distinct market.

The model is called the Five Forces model, because Porter suggests that there are five factors or 'forces' that affect the competitive position of a company in a market. These five forces are:

- existing competitors and the rivalry between existing competitors
- the threat from new entrants to the market
- the bargaining power of suppliers
- the bargaining power of customers
- the threat from substitute products.

Illustration: Five forces



A management information system should be able to provide measures relating to each of these five forces, to assist management in making decisions about competitive strategy.

4.2 Existing competitors and competitive rivalry

The strength of competition varies between different markets. Some markets have several rival companies competing for customers. Other markets are dominated by a single company, although there may be some small and weak competitors.

When competition is strong, companies are likely to pursue active competitive strategies to retain existing customers and win new customers from their rivals. They might compete by offering lower prices, a wider range of products or products with a superior design or quality. For example, in the UK the retail market for food products is dominated by four large supermarket chains (Tesco, Sainsbury's, Asda and Morrisons), which compete with each other mainly on the basis of price, product range and location (convenience).

In a competitive market, an initiative by one company – such as a decision to reduce prices of some goods – is often copied quickly by its rivals. Gains in market share might therefore be short-lived.

Companies in a competitive market try to retain or increase their share of the market, and important information for management is therefore information about:

- ❑ growth in the total market, and
- ❑ the market share of each competitor in the market.

If a company is losing market share, or if a competitor is gaining market share, this might indicate a weakness with the company's existing strategies.

Switching costs

Switching costs might affect the strength of competition in a market. Switching costs are the costs that a customer would incur by switching from one supplier to another. In some industries and markets, switching costs might be high. For example, it might be necessary to train employees in a different technology of the new supplier.

Switching costs might be high, for example, if a customer is considering a switch to a new supplier of software. All the existing data files would have to be converted to a format suitable for the new software and employees would have to be trained to use the new system.

4.3 Threat from new entrants

In some markets, it is difficult for new competitors to enter the market. (The 'barriers to entry' are high.) This may be because entry to the market would require a large capital investment, and any company entering the market would therefore be taking a big risk.

The strength of the threat from new entrants depends on the strength of the barriers to entry. Barriers to entry may not prevent competitors entering the market eventually, but they can delay the entry of new competitors.

The nature of barriers to entry

A variety of factors might create strong barriers to entry.

- **Economies of scale**. Economies of scale refer to the ability of an entity to reduce the average cost per unit of sales by producing and selling a larger quantity of the product. They occur for a variety of reasons:
  - By making and selling more units, fixed costs are spread over a larger quantity and fixed costs per unit fall.
  - An entity might be able to use larger machines that can produce larger quantities more efficiently than smaller machines.
  - An entity might be able to buy materials at a lower cost, by purchasing in larger quantities.
- **Capital investment**. Entering a new market might require a large capital investment. This might deter a new entrant, because the investment could be high-risk.
- **Customer loyalty**. Entities already operating in the market might have strong customer loyalty and a strong brand name. This would make it difficult for a new entrant to win market share.
- A barrier to entry might exist in the form of **legal or political protection**. For example, the products made by a company already in the market might be protected by patent. Government protection might be provided in the form of an import ban or by law. An example in 2006 was the failure of European online gambling firms to enter the US market, because of US legislation against online gambling. This legislation protected companies that operated casinos in the US.

Weak barriers to entry

In some markets, barriers to entry might be low, and it might be fairly easy for new competitors to enter the market. This is often the case with markets for services, where the service relies on the skill or expertise of the service provider. For example, it is often fairly easy for a professional person, such as an architect or a solicitor to set up in business.

Occasionally, technological changes might reduce barriers to entry and make it easier for new companies to enter. For example, the Internet has made it possible for some companies to enter a market by offering goods or services for sale on the Internet. Selling through a web site avoids the need for large investments in retail stores or office property.

Barriers to entry would be lowered if the government offered a subsidy or grant to companies that invested in a particular industry.

A management information system should be able to provide information about any new entrants to the market, the type of product or service they are providing, the prices they are charging and the success they seem to be having in attracting customers.

4.4 Bargaining power of suppliers

The competitive position of a company in its market might be affected by the ability of one or more key suppliers to influence the market. Suppliers can have a very strong influence when:

- there are very few suppliers to the market, and
- there are a large number of companies in the market, buying from the same suppliers.

An example is the influence of producers of oil and natural gas over the energy markets.

Powerful suppliers might be able to increase prices or control the supply of their product to the market. Companies in the market are exposed to the risk that the cost or the supply of a key resource could be changed by their supplier's decision.

Companies in a market should try to:

- avoid reliance on a single supplier, if possible, and try to use several different suppliers, or
- develop close strategic relationships with key suppliers.

When suppliers have a strong influence over a market, a company's management information system should provide information about:

- the number and identity of suppliers in the market
- their prices
- the proportion of total purchases of key products that are obtained from each supplier.

4.5 Bargaining power of customers

The competitive position of a company might also be affected by reliance on one or a small number of customers. An entire market might be dominated by a small number of potential customers. For example, the market for sophisticated weapons systems is influenced by the power of the rich governments that can afford to buy them. Similarly, the market for large passenger aircraft is strongly influenced by the bargaining power of the fairly small number of airline companies that might buy them.

The bargaining power of customers is particularly strong in markets where there is a large number of suppliers but only a few customers. The UK retail market for food was referred to earlier. In this market, there are only four major supermarket chains, which buy a large proportion of all food products sold in the UK, but there are large numbers of small suppliers. The powerful buyers are often able to dictate terms to the suppliers, and can threaten to switch to different suppliers if they do not get what they want.

When customers have a strong influence over a market, a company's management information system should provide information about:

- the number and identity of the major customers in the market
- what these customers are asking for, in terms of product or service quality and price
- the proportion of the company's total sales that are made to each major customer.

4.6 Threat from substitute products

The competitive strength of a company might also be affected by the existence of substitute products. The company needs to be aware that its competitive strategy could result in a switch of customer demand to or from a substitute product.

For example, an increase in the worldwide price of tea could lead to a switch in demand from tea to coffee. Similarly, higher prices for travel by railway could lead to a switch by customers to alternative forms of transport, such as air or road.

When there are close substitutes for a company's products or services, management should be provided with market information about these substitutes. For example, a company that supplies tea should monitor the market for coffee and other drink products.

5 BOSTON CONSULTING GROUP (BCG) MODEL

Section overview

- The BCG matrix: market growth (potential) and market share (profitability)
- Categories of product in the BCG matrix
- Structure of the BCG matrix
- Using the BCG matrix for planning and performance measurement
- Weaknesses in BCG model analysis

5.1 The BCG matrix: market growth (potential) and market share (profitability)

In competitive markets, management need information to evaluate their products (or services) in terms of their:

- market potential, and
- ability to generate profits and cash flows for the business.

The Boston Consulting Group matrix (or BCG matrix) is a model that can be used to assess which products should be developed for future growth, and whether a business entity has an appropriate mix of products for achieving future growth. It incorporates the concept of the product life cycle. It is useful for companies that provide a number of different products (or services) for different markets.

The BCG matrix can be drawn as a 2 × 2 matrix, which 'maps' each product that a company sells, in terms of:

- the expected growth in the market as a whole, and
- the share of the total market that is currently held by the company's product.

5.2 Categories of product in the BCG matrix

Products are categorised into four types:

- stars
- cash cows
- dogs
- question marks.

Stars

Stars are products where the market is growing at a fast rate, and the product enjoys a large share of the total market. They are normally new products. Stars might not yet be profitable, but new investment in the product should provide high financial returns in the future. Entities need 'stars' in order to succeed in the future, and so should invest in them.

Because the market is strong and growing, there are no problems with over-capacity in production and over-supply to the market. This means that the company has some control over prices that it can charge. (It may choose between a pricing strategy of 'market penetration' or 'market skimming'. These pricing strategies are explained in another chapter.)

A 'star' product has more potential for profits, and it is worthwhile to invest more money in the product, to increase sales.

Eventually when the growth in sales slows down, a star will become a cash cow. In other words, a product that is a star early in its life cycle will become a cash cow during the mature stage of the product's life.

Cash cows

Cash cows are products where the market is growing slowly, or is not growing at all, and the product enjoys a large share of the total market. These products are very profitable and provide large cash inflows for the entity. Every company needs cash cows to survive in the long-term. The cash from cash cows helps to finance investment in stars. Eventually, cash cows must be replaced when the product reaches the end of its economic life.

The strategy for a cash cow should be maintaining and protecting the position of the product in its market, and to keep costs under control (or reduce costs). The strategy should not be to seek more sales growth, because the product has no further growth potential (or very little further growth potential).

Dogs

Dogs are products where the market is growing slowly, or is not growing at all, and the product has only a small share of the total market. These products are often (but not always) losing money. The correct strategic decision is usually to withdraw the product from the market.

Question marks

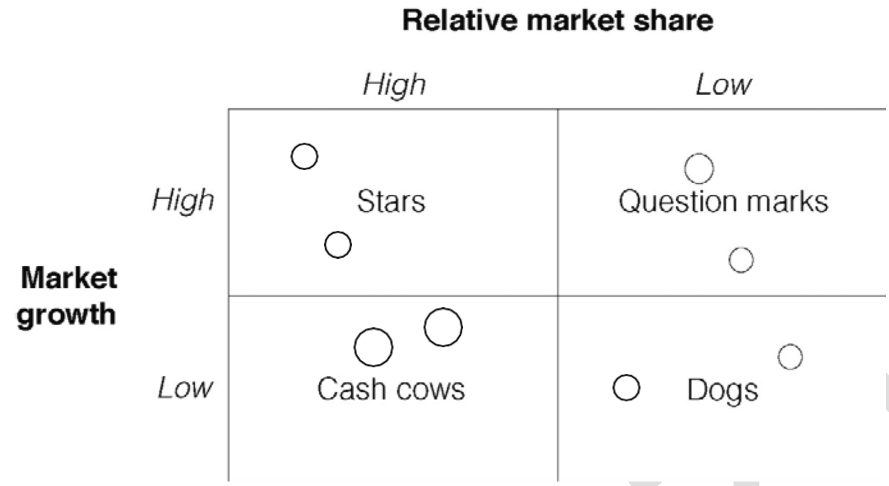
Question marks (also called 'problem children') are products where the market is growing at a fast rate, but the company's product has only a small share of the total market. These products are currently losing money. New investment in 'dogs' (for example, more investment in research and development or marketing) might turn a 'question mark' into a 'star', but there is also a risk that it will become a 'dog' when the growth in the market slows down. Investing in these products will be a strategic gamble.

5.3 Structure of the BCG matrix

A BCG matrix is shown below. The individual products (or business units) can be plotted in the matrix as a circle. The size of the circle shows the relative money value of sales for the product. A large circle represents a product with large annual sales.

The position of the products in each quadrant also shows the relative rate of growth in the total market, and the relative share that the company's product has in the total market.

Illustration: BCG matrix



5.4 Using the BCG matrix for planning and performance measurement

Companies can use the BCG matrix to analyse the range of products that it sells, and to plan its future investment in products. The aim should be to ensure that there is a sufficient investment in 'stars', and that cash cows will generate enough cash flow to finance most or all of this investment.

To carry out an analysis, information is needed for each product about:

- Total market size
- Rate of growth in the total market
- The company's share of the total market
- Changes in the company's share of the total market.

Example: BCG matrix

A company produces five different products, and sells each product in a different market.

The management accountant has obtained the following information about market size and market share for each product. It consists of actual data for each of the last three years and forecasts for the next two years.

	Year - 2 Actual	Last year Year -1 Actual	Current year Actual	Next year Year + 1 Forecast	Year + 2 Forecast
Product 1					
Total market size (₦ million)	50	58	65	75	84
Product 1 sales	2	2	2.5	3	3.5
Product 2					
Total market size (₦ million)	150	152	149	153	154
Product 2 sales	78	77	80	82	82
Product 3					
Total market size (₦ million)	40	50	60	70	80
Product 3 sales	3	5	8	10	12
Product 4					
Total market size (₦ million)	60	61	61	61	60
Product 4 sales	2	2	2	2	2
Product 5					
Total market size (₦ million)	100	112	125	140	150
Product 5 sales	4	5	5.5	6	6.5

In the current year, the market share of the market leader, or the nearest competitor to the company, has been estimated as follows:

	Market share of market leader or the company's nearest competitor
Market for:	%
Product 1	37
Product 2	26
Product 3	12
Product 4	29
Product 5	20

Required

(a) Using the Boston Consulting Group model, how should each of these products be classified?

(b) How might this analysis help the management of the company to make strategic decisions about its future products and markets ('product-market strategy')?

Answer

A **star** is a product in a market that is growing quickly, where the company's product has a large market share or where the market share is increasing. **Product 3** appears to be a star. The total market is expected to double in size between Year – 2 and Year + 2. The expected market share in two years' time is 15%, compared with 7.5% in Year – 2. Its market share in the current year is over 13%, which makes it the current market leader.

A **cash cow** is a product in a market that has little or no growth. The market share, however, is normally quite high, and the product is therefore able to contribute substantially to operational cash flows. **Product 2** appears to be a cash cow. In the current year its market share was over 53%, and it is the market leader.

A **dog** is a product in a market with no growth, and where the product has a low share of the market. Dogs are likely to be loss-making and its cash flows are probably negative. **Product 4** appears to be a dog. The total market size is not changing, and the market share for product 4 is only about 3%. This is much less than the 29% market share of the market leader.

A **question mark** is a product with a fairly low market share in a market that is growing fairly quickly. **Product 1** appears to be a question mark. The total market is growing quite quickly, but the market share of Product 1 is about 4% and this is not expected to change. **Product 5** also appears to be a question mark, for the same reason.

The company should decide on its strategy for the products it will sell.

It should benefit from the cash flows generated by its only cash cow, Product 2.

It should invest in its star, Product 3, with the objective that this will eventually become a cash cow.

It should give serious consideration to abandoning its dog, Product 4, and withdrawing from the market.

It has to make a decision about its two question marks, Product 1 and Product 5. The main question is whether either of these products can become a star and cash cow. Additional investment and a change of strategy for these products might be necessary, in order to increase market share.

For all the products (with the exception of Product 4, if this is abandoned) the company should also consider ways of making the products more profitable. Techniques such as **value chain analysis** might help to identify cost savings.

5.5 Weaknesses in BCG model analysis

There are several criticisms of the BCG model.

- The BCG model assumes that the competitive strength of a product in its market depends on its market share, and the attractiveness of a market for new investment depends only on the rate of sales growth in the market. Unless a product can achieve a large share of the market, it is not sufficiently competitive. Unless a market is growing quickly enough, it is not worthwhile to invest more money in it. It can be argued that these assumptions are incorrect.
  - A product can have a strong competitive position in its market, even with a low market share. Competitive strength can be provided by factors such as product quality, brand name or brand reputation, or low costs.
  - A company might benefit from investing in an industry or market where sales growth is low.
- It might be difficult to define the market.
  - There might be problems with defining the geographical area of the market. A market might be defined in terms of a single country, a region of a country or as an international or global market.
  - It might also be difficult to identify which products are competing with each other. For example, the total market for cars may be divided into different categories of car, but there may be problems in deciding which models of car belong to each category.
- It might be that the BCG matrix is better for analysing the performance of strategic business units (SBUs) and market segments. It is not so useful for analysing entire markets, which might consist of many different market segments.
- It might be difficult to define what is meant by 'high rate' and 'low rate' of growth in the market. Similarly, it might be difficult to define what is meant by 'high' market share and 'low' market share.

6 VALUE CHAIN ANALYSIS

Section overview

- Creating value and competitive advantage
- The value chain
- A value chain for a company handling physical resources

6.1 Creating value and competitive advantage

A business is often organised into a series of departments or divisions each of which might undertake a different function. In practice value is added by a series of activities and processes which occur in a coordinated way. These activities and processes must be linked effectively to add value.

Value chain analysis is a model that gives insight into such business integration.

Value relates to the benefit that a customer obtains from a product or service. Value is provided by the attributes of the product or service. Customers are willing to pay money to obtain goods or services because of the benefits they receive. The price they are willing to pay puts a value on those benefits.

- A customer will often be willing to pay more for something that provides more value.
- Given a choice between two competing products or services, a customer will select the one that provides more value (in terms of value for money, quality, reliability, functions, convenience, and so on).

Business entities create added value when they make goods and provide services. For example, if a business entity buys a quantity of components for ₦1,000 and converts them into a wrist watch that it sells for ₦10,000, it has created value of ₦9,000.

In a competitive market, the most successful companies are those that are best at creating value. Michael Porter has argued that companies in a competitive market must seek competitive advantage over their rivals. They do this by creating more value and by creating value more effectively, more efficiently or at less cost.

Porter suggested that an entity can adopt either of two competitive strategies:

- a cost leadership strategy, where its aim is to create the same value as its competitors in the products it makes or the services it provides, but at a lower cost;
- a differentiation strategy, where its aim is to create more value than its competitors, for a competing product or service, so that customers are willing to pay more to buy it.

6.2 The value chain

Porter (**Competitive Strategy**) developed the concept of the value chain. A **value chain** refers to inter-connected activities that create value. He argued that activities within an organisation can be analysed into different categories.

- ❑ Value can be created by any of these activities.
- ❑ Management should analyse these value-creating activities to identify where the organisation was most effective at creating value, and where it was least effective.
- ❑ Similarly, management can identify which activities give them a competitive advantage over rivals.

By analysing value-creating activities, decisions can be made about:

- ❑ how the creation of value can be improved
- ❑ how to improve a competitive advantage over rivals, and
- ❑ whether some activities should be stopped because they cost more than the value they create.

6.3 A value chain for a company handling physical resources

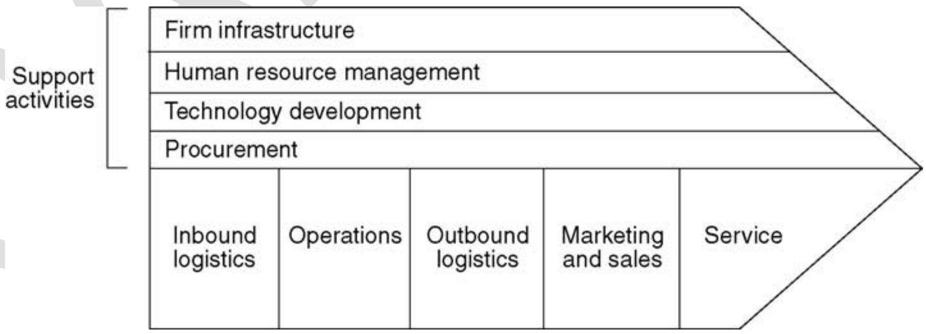
Porter's value chain is most commonly associated with the analysis of value creation in a company that handles physical resources, such as a manufacturing company or a retailing company.

Value-creating activities are grouped into two broad categories:

- ❑ primary activities; and
- ❑ support activities.

These are divided into five primary activities and four support activities.

Illustration: Porter's value chain



Most value is usually created in the primary value chain.

- **Inbound logistics**. These are the activities concerned with receiving and handling purchased materials and components, and storing them until needed.
- **Operations**. These are the activities concerned with converting the purchased materials into an item that customers will buy. In a manufacturing company, operations might include machining, assembly, packing, testing and equipment maintenance.
- **Outbound logistics**. These are activities concerned with the storage of finished goods before sale, and the distribution and delivery of goods (or services) to the customers.
- **Marketing and sales.**
- **Service**. These are all the activities that occur after the point of sale, such as installation, repairs and maintenance, and after-sales service.

The nature of the activities in the value chain varies from one industry to another, and there are also differences between the value chain of manufacturers, retailers and other service industries. However, the concept of the primary value chain is valid for all types of business entity.

It is important to recognise that value is added by all the activities on the primary value chain, including logistics. Customers might be willing to pay more for a product or a service if it is delivered to them in a more convenient way. For example, customers might be willing to pay more for household shopping items if the items are delivered to their home, so that they do not have to go out to a supermarket or a store to get them.

Secondary value chain activities: support activities

In addition to the primary value chain activities, there are also secondary activities or support activities. Porter identified these as:

- **Procurement**. These are activities concerned with buying the resources for the entity – materials, plant, equipment and other assets.
- **Technology development**. These are activities related to any development in the technological systems of the entity, such as product design (research and development) and IT systems.
- **Human resources management**. These are the activities concerned with recruiting, training, developing and rewarding people in the organisation.
- **Corporate infrastructure**. This relates to the organisation structure and its management systems, including planning and finance management.
- Support activities are often seen as necessary 'overheads' to support the primary value chain, but value can also be created by support activities. For example:
  - procurement can add value by identifying a cheaper source of materials or equipment
  - technology development can add value to operations with the introduction of a new IT system
  - human resources management can add value by improving the skills of employees through training.

Primary activities	Examples
Inbound logistics	Delivery systems for materials and components, warehouses for accepting deliveries
Operations	For a manufacturing company, manufacturing operations and methods: total quality management methods, just-in-time production methods and so on.
Outbound logistics	Warehousing for finished goods, methods of delivering goods to customers
Marketing and sales	Advertising and sales promotion methods, taking and processing sales orders, pricing
Service	After-sales service, handling customer queries and complaints

Support activities	Examples
Firm infrastructure	Centralised/decentralised management structure, size of head office, head office services, size of management hierarchy, decision-making processes
Human relations management	Recruitment policies, training policies, incentive (bonus) pay arrangements, employee skill levels
Technology development	Use of IT and IT systems, age of IT systems, use of e-commerce
Procurement	Choice of suppliers, arrangements with suppliers, just-in-time purchasing, negotiation of prices, credit terms and discounts with suppliers.

For each individual activity listed within each of these categories of activity, it should be possible to analyse what the company does well (creating value) and what it does less effectively.

It is also possible to use value chain analysis to identify the **information requirements** for each activity, to ensure that it can create value.

7 SWOT ANALYSIS

Section overview

- The nature of SWOT analysis
- Strengths and weaknesses
- Threats and opportunities
- Preparing a SWOT analysis
- Strategic management accounting and SWOT analysis

7.1 The nature of SWOT analysis

SWOT analysis is a technique used in strategic planning for identifying key factors that might affect business strategy. These factors are both internal to the company and external, in its environment. SWOT analysis can be used in the strategic planning process to analyse the company's capabilities and core competencies (or lack of them) and also to carry out an environmental analysis.

SWOT analysis is an analysis of strengths, weaknesses, opportunities and threats.

- **S** Strengths. Strengths are internal strengths that come from the resources of the entity.
- **W** Weaknesses. Weaknesses are internal weaknesses in the resources of the entity.
- **O** Opportunities. Opportunities are factors in the external environment that might be exploited, to the entity's strategic advantage.
- **T** Threats. Threats are factors in the external environment that create an adverse risk for the entity's future prospects.

Strengths and weaknesses are concerned with the internal capabilities and core competencies of an entity. Threats and opportunities are concerned with factors and developments in the environment.

In order to prepare a SWOT analysis, it is necessary to:

- analyse the internal resources of the entity, and try to identify strong points and weak points
- analyse the external environment, and try to identify opportunities and threats.

7.2 Strengths and weaknesses

Strengths and weaknesses relate to factors within the entity, such as the strength and weaknesses of its processes and systems, its resources, its management and its track record of success or failure in the past.

Senior management in a company might have their own opinion of the strengths and weaknesses of the company, but a management information system should be able to provide **measured** and reliable information about strengths or weaknesses.

The table below contains examples of activities, processes and resources where there might be strengths or weaknesses that could have strategic significance.

Products and brands	Strength of the brand name Quality of products (or services) The portfolio of products, assessed in terms of (1) stages in their life cycle, or (2) a Boston Consulting Group portfolio analysis Profitability and return on capital Contribution to cash flow
Research and development	Number of innovations Success rate for new innovations Speed of innovation: speed in responding to new products of competitors Costs
Marketing	Abilities of the sales force Success in the past in selling products Efficiency of 'channels of distribution' – making the product available to customers Network of intermediaries – retail stores, agents or distributors Market size Market share Numbers of regular customers Customer service operations
Distribution/delivery	Location of distribution centres Cost of distribution Fleet of delivery vehicles
Finance	Availability of long-term capital Availability of short-term funding (cash) Profitability Operational cash flows Return on investment Credit control, collection of receivables, bad debts
Assets (buildings, equipment)	Type and value of assets Quality of assets Production capacity Location of assets

Employees and managers	Skills and experience Training Loyalty Motivation Industrial relations
Organisation and management	Centralised/decentralised management Management style Information systems
Suppliers and inventory	Relationship with key suppliers Storage capacity for inventory Speed of inventory turnover

7.3 Threats and opportunities

An information system should provide information to management about threats and opportunities in the environment. The sources of this information are outside the entity itself. There might be a wide range of information sources, such as official publications, newspaper reports, government statistics, physical observation of competitors and customers, and discussions with suppliers.

The nature of threat and opportunities in the environment can be classified into several broad groups. One method of classification is known as PESTEL:

Political threats and opportunities	Government regulations, for example, towards giving permission for new business developments and construction projects. Government policy, for example towards government spending programmes. Consequences of a change of government.
Economic threats and opportunities	Economic change: rate of economic growth or recession Exchange rates Interest rates Anti-monopoly regulations Rate of inflation Taxation
Social threats and opportunities	Social change: for example changes in the age distribution of the population Cultural change: for example, changes in leisure activities Movements in the population
Technological threats and opportunities	Any technological or scientific development

Environmental threats and opportunities	Cost and availability of forms of energy Pollution Preservation of the environment: sustainable business
Legal threats and opportunities	New laws Decisions by a court of law

7.4 Preparing a SWOT analysis

A SWOT analysis might be presented as four lists, in a cruciform chart, as follows: (Illustrative items have been inserted, for a small company producing pharmaceuticals).

Example: SWOT analysis

Strengths	**Weaknesses**
Extensive research knowledge Highly-skilled scientists in the work force High investment in advanced equipment Patents on six products High profit margins	Slow progress with research projects Poor record of converting research projects into new product development Recent increase in labour turnover
Opportunities	**Threats**
Strong growth in total market demand New scientific discoveries have not yet been fully exploited	Recent merger of two major competitors Risk of stricter regulation of new products

In order to prepare a SWOT analysis, it is necessary to:

- ❑ analyse the internal resources of the entity, and try to identify strong points and weak points
- ❑ analyse the external environment, and try to identify opportunities and threats.

7.5 Strategic management accounting and SWOT analysis

Management accounting systems should be able to support SWOT analysis by management, by providing relevant information. Much of this information can be quantified.

In the example above of the pharmaceuticals company, it should be possible to provide quantified data about items such as:

- ❑ time to complete research projects
- ❑ percentage of research projects that move on to a development phase
- ❑ amount invested in capital equipment
- ❑ labour turnover rates (compared to average labour turnover in the industry)
- ❑ profit margins
- ❑ growth in total market demand and annual sales.

8 ANSOFF'S GROWTH VECTOR ANALYSIS

Section overview

- Four product market strategies for growth
- Market penetration strategy
- Product development strategy (innovation strategy)
- Market development strategy
- Diversification strategy
- Ansoff's growth vector and gap analysis
- Management information

8.1 Four product market strategies for growth

Ansoff's growth vector analysis (Ansoff's grid) is another model for strategic development and growth.

The Ansoff growth vector might be presented as follows:

Illustration: Ansoff's grid

		Current	New
Market	Current	Market penetration	Product development
	New	Market development	Diversification

The model identifies four strategies for developing products and markets in order to grow the business.

The four strategies are as follows:

- ❑ Market penetration
- ❑ Product development (innovation)
- ❑ Market development
- ❑ Diversification

8.2 Market penetration strategy

This is a strategy of trying to gain higher sales in the entity's current markets with its existing products. Market penetration is achievable:

- ❑ when the total market is growing, or
- ❑ by increasing market share.

For example, a company providing mobile telephone services might pursue a market penetration strategy, by trying to sell to more customers. This is possible if the total demand for mobile telephone services is increasing, or by taking market share from competitors.

A market penetration strategy is a low-risk strategy, and is unlikely to result in a high rate of sales growth. The product is not altered and there is no attempt to find new markets for the product.

8.3 Product development strategy (innovation strategy)

This is a strategy for growth that involves developing new products for existing markets and customers. For example, a software company might develop a new product or enhanced product that it tries to sell to its existing customers. Similarly, a car manufacturer might develop a new model of car, which it then tries to sell to its existing customers.

8.4 Market development strategy

This is a strategy of trying to enter new markets for the entity's existing products. In other words, it is a strategy of selling current products to new customers by finding a new market, or a new market segment. For example:

- a supermarkets company might try to increase its sales by entering the market for Internet shopping and home delivery
- a company might grow by trying to enter markets in other countries.

8.5 Diversification strategy

This is a strategy of developing new products for new markets. A diversification strategy is a high-risk strategy, because the company needs to develop a new product that will meet customer needs successfully, but it does not yet have much knowledge or understanding of customers in the market and what their needs might be.

There are two types of diversification:

- **Related diversification**, where the business entity develops new products and markets that are in a related industry. For example, a manufacturer of ice cream might diversify into producing soft drinks.
- **Unrelated diversification**, where the business entity develops new products and markets that are in an industry where it has no previous experience. For example, a manufacturer of ice cream might diversify into making and selling shoes.

Unrelated diversification is usually a much higher-risk strategy than related diversification. However, even a strategy of related diversification can be a high risk.

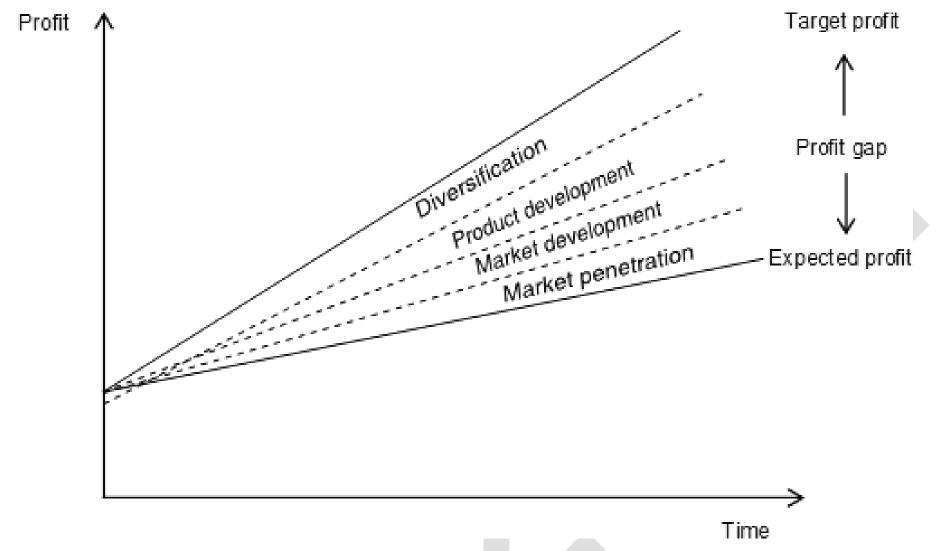
8.6 Ansoff's growth vector and gap analysis

Ansoff's growth vector can be used together with gap analysis. Gap analysis is the analysis of the difference between a strategic target and the expected performance that will be achieved without any new strategies.

For example, a company might measure the gap between the profits it would like to make in five years' time and the profits it would expect to make if it did not undertake any new growth strategy.

Having estimated the size of the profit gap, the company can then consider growth strategies to increase profitability. The contribution of each growth strategy to profits can be estimated. Together, a combination of growth strategies might enable a company to close the profit gap and pursue strategies that will enable it to meet its targets.

Illustration: Strategies to fill the profit gap



8.7 Management information

Management should be provided with information that helps them to monitor the success of their growth strategy. The items of information that might be provided include:

- Potential market demand
- Market size
- Market share
- Information about competitors and their products
- Pricing information
- Information about costs
- Information about required investment and financing
- Estimated returns from a chosen strategy
- The risks in the chosen strategy.

9 MARKETING

Section overview

- The marketing approach
- Customer needs
- The 4Ps of the marketing mix
- C Analysis

9.1 The marketing approach

As stated earlier, markets can be defined by their customers and potential customers. Companies and other business entities compete with each other in a market to sell goods and services to the customers. The most profitable entities are likely to be those that sell their goods or services most successfully.

Business success is achieved by providing goods or services to customers in a way that meets customer needs successfully.

Customers will buy from the business entities that meet their needs most successfully.

Much business strategy is based (partly) on the marketing approach or the marketing concept, which is that the aim of a business entity is to deliver products or services to customers in a way that meets customer needs better than competitors. To do this, the business entity must have a competitive advantage over its competitors, and a strategic aim is to achieve a competitive advantage, and then keep it.

9.2 Customer needs

Customers buy products or services for a reason. When they can choose between two or more competing products, there is a reason why they choose one product instead of another.

A major factor in the decision to buy a product is usually price. Many customers choose the product that is the cheapest on offer, particularly when they cannot see any significant difference between the competing products.

If the buying decision is not based entirely on price, the customer must have other needs that the product or service provides. These could be:

- ❑ a better-quality product;
- ❑ better design features;
- ❑ availability: not having to wait to obtain the product;
- ❑ convenience of purchase;
- ❑ the influence of advertising or sales promotions.

There are many different types of customer, each with their own particular needs. A product that meets the needs of one customer successfully might not meet the needs of another customer nearly as well.

Customers may be grouped into three broad types:

- consumers: these buy products and services for their personal benefit or use;
- industrial and commercial customers: customers might include other business entities;
- government organisations and agencies.

In some markets, most customers are consumers. In industrial markets, all customers are industrial and commercial customers, and possibly some government customers. In some markets, such as the markets for military weapons, the only customers are governments.

As a general rule, the needs of different types of customer vary. Industrial and commercial customers are more likely than consumers to be influenced by price. Consumers will often pay more for a branded product (due to the influence of advertising) or for convenience.

9.3 The 4Ps of the marketing mix

The marketing approach is to identify customer needs and try to meet customer needs more successfully than competitors. To do this, business entities need to offer or provide a 'mix' of the four Ps that will appeal to customers. The 4Ps are:

- Product
- Price
- Place
- Promotion.

Product refers to the design features of the product, and the product quality. In addition to the product itself, features such as short lead time for delivery and reliable delivery could be important. Product features also include after-sales service and warranties. For services, the quality of service might depend partly on the technical skills and inter-personal skills of the service provider.

Price is the selling price for the product: some customers might be persuaded to purchase by a low price or by the offer of an attractive discount.

Place refers to the way in which the customer obtains the product or service, or the 'channel of distribution'. Products might be bought in a shop or supermarket, from a specialist supplier, by means of direct delivery to the customer's premises or through the internet.

Promotion refers to the way in which product is advertised and promoted. It includes direct selling by a sales force (including telesales).

Marketing can be analysed at a tactical level, and decisions about the marketing mix might be included within the annual marketing budget. However, marketing issues can also be analysed at a strategic level.

It is important in strategic analysis to understand what customers will want to buy, and why some products or services will be more successful than others.

9.4 C Analysis

Once the goals and targets of the marketing effort are known the next step is to develop the marketing strategy.

The 5 Cs provides a useful framework for constructing a marketing strategy.

Customer: The needs of customers that are to be met must be determined. Information should be gathered on market segments, benefits the customer wants, whether value of the benefits outweigh the costs, frequency of purchases, quantity of purchases, retail channels, and needs based on trends over time.

Company: – Whether the company can meet those customer needs must be determined. For example, does the company have the right product line and/or technical expertise? SWOT analysis can be used to answer these questions.

Competition: – Determine who competes with the company in meeting the customers' needs:

- ❑ Is it an active competitor or a potential threat?
- ❑ What is their offering?
- ❑ What are their strengths and weaknesses?

Collaborators: Determine if there is any outside source that can help the company such as distributors, suppliers, etc.

Context: Determine if there are any limitations due to factors in the environment (for example, regulations, taxation etc.).

10 BENCHMARKING

Section overview

- The purpose of benchmarking
- The potential benefits of benchmarking
- Methods of benchmarking
- Internal benchmarking: league tables
- Competitive benchmarking
- Process benchmarking
- Customer benchmarking
- Strategic benchmarking
- Functional benchmarking
- Product benchmarking (reverse engineering)
- Requirements for successful benchmarking
- Problems with benchmarking

10.1 The purpose of benchmarking

Benchmarking is a process of setting standards or targets for products, services or work processes with reference to organisations that are recognised as models of 'best practice'. A benchmark is an organisation that provides the 'best practice' for comparison. An entity uses benchmarking to evaluate its own products, services or work processes by comparing them with the 'best practice' of the benchmark organisation.

The purpose of benchmarking is to identify measures that need to be taken to improve or change, so that the organisation becomes as good as, or better than, the benchmark.

Definition of benchmarking

'Benchmarking is the continuous process of measuring products, services and practices against the toughest competitors or the companies recognised as industry leaders ("best in class")' (The Xerox Company).

The benchmarking process

Benchmarking should be a continuous process, and it usually consists of the following stages:

- ❑ Identify aspects of performance that should be compared with a 'benchmark partner'.
- ❑ Select a suitable benchmark (a 'benchmark partner').
- ❑ Compare the product, service or process with the benchmark.
- ❑ Identify gaps in performance between the benchmark and the entity's own product, service or process.
- ❑ Identify changes that can be made to improve performance.
- ❑ Implement the improvements.

- Monitor the success of the changes in improving performance, and measure the benefits.

10.2 The potential benefits of benchmarking

Benchmarking can offer several benefits.

- It can be used to identify aspects of performance that are weak, where improvements are necessary.
- It can be used to set targets for improvement that are realistic and practicable.
- It can be used to look at practices in companies in different industries, and to learn from them.
- It encourages continuous improvement: benchmarking encourages managers and employees to make improvements, and to believe that changes are necessary.

10.3 Methods of benchmarking

There are several methods of benchmarking:

- internal benchmarking
- competitive benchmarking
- process benchmarking
- customer benchmarking.

Benchmarking can also be grouped into the following categories:

- strategic benchmarking
- functional benchmarking
- 'best practices' benchmarking (process benchmarking)
- product benchmarking.

10.4 Internal benchmarking: league tables

Internal benchmarking uses a benchmark inside the organisation itself. Other parts of the same organisation are compared with the benchmark.

For example, a company might have several regional or area offices. The best-performing regional office might be taken as a benchmark, and the other regional offices are compared with it. The benchmarking exercise should identify the reasons why each region has not performed as well as the benchmark. When the reasons for the worse performance are recognised, plans can be made to deal with the problems and achieve improvements.

League tables

One method of making internal benchmarking comparisons is to establish a league table. Points may be awarded for various aspects of performance, and for each profit centre or division, a total points score is calculated, depending on how well or badly it has performed for each of the aspects.

A league table may then be published, with the 'winners' scoring the most points and the 'losers' at the bottom of the league table.

League tables may also be used within the not-for-profit sector. In the UK for example, state-owned schools are ranked within league tables, according to their relative success or failure in major national examinations.

The use of league tables is intended to encourage improvements in performance through competition – no division wants to be at the bottom of the table and many will want to be at the top.

In principle, each division is measured according to the same key or critical measures of performance, and the system should therefore be 'fair'. However, many local' factors will affect the performance of a particular division. In comparing the performance of schools, for example, much depends on the quality of the students, and it is unfair to compare the performance of a state school in a prosperous neighbourhood with the performance of a school in a 'ghetto' community.

A further problem is that divisional managers may be made responsible for aspects of performance that are outside their control, especially where the level of performance involves the co-operation between two or more divisions. It is unfair to assess the performance of a division on factors that are outside the control of its management.

Finally, league tables (like other measures of performance) encourage 'cheating', such as trying to hide unfavourable data. Divisional managers may also take action to improve short-term performance even if this has adverse implications for longer-term results. The league tables may therefore become the main focus for management, instead of the actual performance levels that the league tables are trying to encourage.

10.5 Competitive benchmarking

Competitive benchmarking uses a successful competitor as the benchmark. A company compares its own products and systems with those of the competitor, and the purpose is to discover the reasons why the competitor is more successful.

When the reasons are identified, plans can be made to improve competitiveness, either by copying what the competitor does, or devising new products or systems that are even better than those of the competitor.

Comparing yourself with the main competitors makes good sense in a competitive business environment. A practical difficulty with competitive benchmarking, however, may be a lack of detailed information about the competitor.

- It should be possible to fully analyse a competitor's products – by buying them and looking at them in close detail.
- However, it may be more difficult to study a competitor's systems and methods of operation in detail. For example, a competitor may have a superior system for handling customers' calls, or a more efficient warehousing system, or a better order processing and despatch system. A rival company will not be allowed to examine these systems in detail.

Example: Benchmarking

Benchmarking began with the Xerox Corporation in the US in 1982. Xerox, a manufacturer of photocopier machines, was in financial difficulties and losing market share to Japanese competitors, who were selling high-quality photocopiers at a much lower price.

Xerox set up a management team that:

1. identified key performance indicators for operations such as order fulfilment, distribution, production costs, retail selling prices and product features, and
2. compared the performance of Xerox in each of these areas against those of its most successful competitors.

Xerox used the findings of its benchmarking exercise to identify areas for improvement. Improvements were made, and as a result customer satisfaction improved, costs were cut and Xerox improved its competitive position in the market.

Other companies followed the example of Xerox, and benchmarking became an established practice for performance measurement.

Example: Competitive benchmarking

In 1991, the Massachusetts Institute of Technology and J D Power and Associates published a survey of car manufacturing plants in Japan, the USA and Europe. Japanese car production was used as a benchmark, and the survey found that productivity was much higher in Japan (where the average time to produce a car was 16.2 man hours) than in Europe (where the average time to produce one car was 36.2 man hours).

The survey analysed possible reasons for the superior performance of Japanese producers, and made comparisons of performance in the areas of training time for new employees, absenteeism and the number of defects per vehicle produced.

The survey provided useful information for US and European car producers, but they had a huge gap to close before they could begin to compete effectively with their Japanese competitors.

Problems with competitive benchmarking

There are several problems with benchmarking the performance of a business against its competitors.

To benchmark effectively it is necessary to obtain meaningful and reliable comparative information about the performance of the competitor. Much of this information, particularly non-financial information, will be unavailable unless the competitor is willing to provide it. If the competitor is a private company and is not required to publish detailed financial statements, comparative financial information may also be difficult to obtain.

There is no reason why a competitor should agree to provide information, unless they too are interested in benchmarking and so would be willing to consider information sharing. The risk of handing over confidential information to a competitor, or providing information that could give a competitor some marketing advantage, is likely to make any company unwilling to agree to such a scheme.

There are some organisations that specialise in taking financial information from firms in the same industry, and providing ‘inter-firm comparisons’ for the participants, without giving away sensitive information about any individual company. However in practice most inter-firm comparison is carried out between quoted companies by stock market analysts.

The cost of benchmarking might be quite high, and too large to justify the benefits to be obtained from a benchmarking system. To deal with this problem, it would be necessary to ensure that the system is kept fairly simple, and as much of the preparation of benchmarking comparisons as possible should be computerised.

There may be problems with getting managers to understand the purpose and benefits of inter-firm comparisons. When benchmarking comparisons are available, managers and other employees need to be told what they should do with it. The purpose and use of benchmarking information would therefore have to be explained clearly to staff, and systems put in place for the monitoring and use of the information obtained.

There may be a risk that a benchmarking exercise with competitors, if practicable, will be used to criticise staff for performing ‘worse’ than competitors. Management must ensure that the system, if put in place, does not create a ‘culture of blame’ that is likely to make employees defensive and resentful.

Competitive benchmarking and competitor analysis

Competitive benchmarking is not the same as competitor analysis. Competitor analysis involves a comparison by a company of its own performance with the performance of its main rivals. A company might draw up a ‘league table’ consisting of itself and its competitors, with the best performer at the top of the table and the worst performer at the bottom. For example, in the UK, some of the major supermarket chains draw up a league table of prices, with the chain offering the cheapest prices at the top of the table and the chain with the highest-price food stores at the bottom.

However, this is not benchmarking. Benchmarking is used to identify differences, and then to develop new ways of doing things, in order to make improvements in performance. The aim should be to make improvements that make the company better than its competitors, rather than improvements that help the company to close the gap with its competitors.

10.6 Process benchmarking

Process benchmarking is the most common method of benchmarking. It involves a comparison of the performance of the entity in one particular activity or process with the performance of another entity in a different industry. This type of benchmarking seeks to identify best practice anywhere, by looking at organisations with a reputation for excellence.

The purpose of process benchmarking is to use a benchmarking approach to analyse operational systems, such as purchasing, call handling (by call centres), order processing, delivery systems, information systems, and so on.

An organisation compares its own practices in an aspect of its operations with those of a benchmark organisation that is in an **unrelated industry** (and so is not a competitor). For example, a company may compare its warehousing and distribution systems with a benchmark organisation, its customer call centre operations or its IT system maintenance arrangements.

A process benchmarking programme is agreed between two organisations which then share information about their systems and compare their performance. Each organisation is able to use the benchmarking process to review its systems and procedures, and look for ways of improving their performance.

Benchmarking can be used as an approach to **improving quality** – in products, services and systems. Comparisons with the 'best' can provide ideas:

- for copying the benchmark organisation, or
- for doing something in a different way, not necessarily in exactly the same way as the benchmark organisation

Example: Process benchmarking

The Xerox Company wanted to improve its performance in dealing with customer orders. It identified Bean, a catalogue retailer specialising in outdoor clothing, as a benchmark for excellence in this area. The two organisations, Xerox and Bean, collaborated with each other in comparing their systems, exchanging information. Xerox management studied the order fulfilment process at Bean and used its findings to improve its own systems.

Process benchmarking can be very effective in helping a company to gain a competitive advantage over its rivals. 'Benchmarking … is not a method for copying the best practices of competitors, but a way of seeking superior process performance outside the industry. Benchmarking makes it possible to gain competitive superiority rather than competitive parity.'

10.7 Customer benchmarking

Customer benchmarking is a completely different approach. This uses the customer as a benchmark, by trying to establish what the customer wants and expects. A company can compare what a customer wants with what the company actually provides.

Gaps can be identified between customer expectations and 'reality', and the company can then look for ways to close the gap.

10.8 Strategic benchmarking

Strategic benchmarking involves a comparison of the strategies of different companies. A company can compare its own strategies with those of its most successful competitor, or with the strategies of successful companies in other industries.

Strategic benchmarking usually involves a comparison with the most successful competitor. A company will use benchmarking to find out why the competitor is more successful. A starting point for the comparison is usually a survey of customers and shared suppliers, to find out what the competitor does better.

Aspects of strategy that might be considered include:

- strategic objectives
- core competencies
- process capability
- products
- strategic alliances
- the use of technology.

10.9 Functional benchmarking

Functional benchmarking is a form of competitor benchmarking. It involves a comparison of performance of a core business function in the company with the performance of the same function in a successful competitor. For example, functional benchmarking might involve a comparison of:

- the sales and marketing function
- the research and development function.

The aim should be to find out why the competitor appears to perform this function more successfully, in order to identify changes and improvements that should be made.

Process benchmarking compares processes in more detail.

10.10 Product benchmarking (reverse engineering)

Product benchmarking, also called reverse engineering, is a form of competitor benchmarking. It involves a comparison of an entity's products with the products manufactured by its main competitors.

The comparison will usually look at:

- the competitor's costs
- product concepts
- strengths and weaknesses in product design and quality.

This product analysis will usually involve obtaining some products of the competitor and analysing them in the workshop or laboratory.

10.11 Requirements for successful benchmarking

There are several requirements for benchmarking to be effective as a way of improving competitiveness.

- It is important to select key aspects of performance for benchmarking. These are the aspects of performance that have to be successful (and improved) in order to gain a competitive advantage over rivals.
- It must be a continuous process, not a 'once only' exercise. Competitors do not 'stand still', and successful competitors will continually innovate and improve. It is essential to keep repeating benchmarking exercises in order to avoid falling behind again as the business environment changes.
- Benchmarking should be a method for becoming better than competitors, not just for closing the gap on competitors and 'catching up'. The aim should be to achieve superior performance.
- When benchmark partners are used for process benchmarking, the collaboration should be open and honest. A company should be prepared to give more information to its benchmark partner than it is hoping to obtain from the benchmark partner.

10.12 Problems with benchmarking

There are several problems that can make it difficult to use benchmarking successfully.

- It might be difficult to identify a critical process where benchmarking could provide valuable information to help an entity improve its performance. Benchmarking might select processes that are not critical to performance. The value of any benefits achieved will therefore be small and insignificant.
- It might be difficult to obtain reliable information for comparison with a benchmark. Even when a 'benchmark partner' is identified for process benchmarking, it could be difficult to get the 'partner' to agree to a benchmarking exercise and then to obtain the required information.

11 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter check that you now know how to:

- Explain, perform and interpret C analysis
- Explain and apply Porter's five forces model to identify industry attractiveness
- Explain and apply the Boston Consulting Group model to identify categories of product (business) in a company's portfolio
- Explain and interpret value chain analysis
- Use Ansoff's grid to identify possible strategic directions
- Explain and apply benchmarking to compare performance against information provided (for example, about a competitor)
- Construct and interpret a SWOT analysis

Skills level
Performance management

CHAPTER 29

Information systems and performance management

Contents

Aim

Performance management develops and deepens student's capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Students will be expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

F	Performance and management systems		
	1	Evaluate and advise management on suitable information technology and strategic performance management system covering:	
		a	Sources of information;
		b	Information technology tools for performance management at various levels (strategic, tactical and operational); and
		c	Use of internet technologies for performance management and key performance indicators.

Exam context

This is the first of the performance management chapters that builds on the information system content of the knowledge level management information paper. We start with a reintroduction of the concepts of information and information systems. We then move on to discussing the levels of information system in the context of performance management.

This chapter addresses the impact of IT in areas such as providers of services, management accounting and competitive advantage before closing with a discussion on critical success factors and key performance indicators, again in the context of information technology and information systems.

By the end of this chapter, you should be able to:

- Describe the types and levels of information used in performance management information systems
- Describe the sources of information including big data
- Explain methods of recording and processing information
- Explain, with examples, the common types of performance management systems and how they may be used for managing performance
- State the qualities of good information and explain concepts of reliability, accessibility, accuracy and security of information
- Summarise the impact IT has had on performance management with respect to the providers of services and management accounting
- Describe the impact IT systems have on competitive advantage
- Define critical success factor (CSFs) and key performance indicator (KPIs)
- Explain the link between CSFs and IS/IT strategy
- Describe how IS/IT is used to monitor CSFs in the achievement of targets

1 PERFORMANCE MANAGEMENT AND INFORMATION

Section overview

- Introduction
- Using information for performance management
- Information and management decisions
- Levels of management: strategic, tactical and operational
- Levels of performance management requirements
- Qualities of good information
- Ensuring reliability and accuracy of information
- Accessibility of information
- Security of information

1.1 Introduction

Performance management incorporates activities that aim to ensure goals are consistently met in an effective and efficient manner. In order to achieve this , management require reliable information systems to support them in:

- Making appropriate decisions;
- Reviewing the results of those decisions as a basis for future decisions and performance management.

In this chapter we re-visit the fundamentals of information systems that you initially encountered in the Management Information paper as the basis for considering information systems in the context of performance management.

1.2 Using information for performance management

Information is processed data. Data can be defined as facts that have not been assembled into a meaningful structure. Data, when processed into a structured form that has meaning, is regarded as information.

Businesses use information in several ways.

- Information is used to perform routine transactions, such as order processing and invoicing.
- Information is used to make decisions.
- Information is also developed into knowledge that can be used to improve the business.

Managers cannot make decisions without information. However, information can vary in quality, and as a general rule managers will make better decisions when they have better quality information.

1.3 Information and management decisions

Decisions are taken continually in business. Routine decisions may be taken by any employee as a part of normal procedures. However, a specific role of management is to make decisions. For this, managers need information.

Managers use information:

- To make plans and reach planning decisions

- To measure performance, and take control action on the basis of comparing actual or expected performance with a target
- To make ‘one-off’ or non-routine decisions
- To communicate decisions to other people
- To co-ordinate activities with other people.

1.4 Levels of management: strategic, tactical and operational

Management may be classified into three levels:

- Strategic management
- Tactical management
- Operational management.

These three classifications are based on the types of decision that are taken by management at each level. For decisions at each level of management, a different type of information is required.

Strategic management

> **Definition: Strategic management**
>
> Strategic management is concerned with setting objectives for the organisation, and developing plans (strategies) to achieve those objectives.

The main objective of a business may be to maximise the wealth of the shareholders, or to achieve continuous growth in sustainable profits, or to be the world leader in a particular industry or market.

Having established the main objectives of the organisation, strategic management is also concerned with developing strategies to achieve the objectives. Strategic planning (and the control of strategy) is concerned with the general direction that the organisation should take, in terms of the markets it operates in, the products or services it provides, and the resources it uses (money, equipment, people, and so on).

Strategic management should have a fairly long ‘planning horizon’. The performance of an organisation in the short term is important, but strategic managers must also focus on the longer term, and the direction in which the organisation is going over the next few years.

Strategic management is the function of the senior managers in an organisation.

Tactical management

> **Definition: Tactical management**
>
> Tactical management has a shorter-term planning horizon than strategic management. It is concerned with:
>
> developing plans and making other decisions within the framework of strategic decisions that have been taken by senior managers
>
> monitoring actual performance to assess whether the planning targets will be achieved
>
> taking control action where necessary to improve performance.

If strategic planning has a planning horizon of up to, say, five to ten years (or longer), tactical management would have a planning horizon of up to about one year or so.

Tactical management is usually associated with budgets and budgetary control, and similar annual plans.

Tactical management is the function of the middle-ranking managers in an organisation. In organisations with a ‘flat’ management structure, however, tactical management decisions may be taken by either senior managers or other managers.

Operational management

> **Definition: Operational management**
>
> Operational management is concerned with the management of day-to-day operations. The planning horizon is short, and in many cases immediate decisions must often be taken about what should be done.

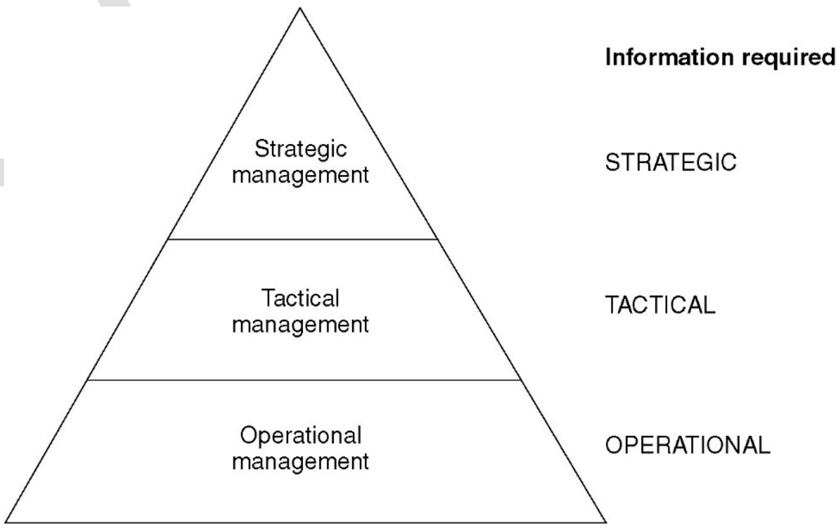
Operational management is often associated with supervision and front-line management. It includes scheduling of operations and monitoring output, such as daily efficiency levels.

There isn’t a clear dividing line between tactical management and operational management, but essentially the differences are a matter of detail. Tactical management may be concerned with the performance of an entire department during a one-week period, whereas operational management may be concerned with the activities of individuals or small work groups on a daily basis.

1.5 Levels of performance management requirements

The requirements of performance management systems vary with the level of management. This concept is set out simply in the diagram below.

Levels of performance management requirements



Strategic information

Strategic performance management needs strategic information. The characteristics of strategic information may be summarised as follows:

- ❑ It is often information about the organisation as a whole, or a large part of it.
- ❑ It is often in summary form, without too much detail.
- ❑ It is generally relevant to the longer term.
- ❑ It is often forward-looking.
- ❑ The data that is analysed to provide the information comes from both internal and external sources (from sources inside and outside the organisation).
- ❑ It is often prepared on an ‘ad hoc’ basis, rather than in the form of regular and routine reports.
- ❑ It may contain information of a qualitative nature as well as quantified information.
- ❑ There is often a high degree of uncertainty in the information. This is particularly true when the information is forward-looking (for example, a forecast) over a number of years in the future.

Illustration: Strategic information for performance management

The board of directors are concerned that the business is not sufficiently diversified which is suppressing the P/E ratio. This is despite having a healthy balance sheet and cash available to invest.

The executive information system (EIS) is used to benchmark the business' against three main competitors with metrics such as:

- ❑ P/E ratio
- ❑ Market share and growth
- ❑ Leverage (debt to equity ratio)
- ❑ Employee numbers

The system is also used to help identify two potential take-over targets and forecast what the combined business would look like, again using the above metrics.

The board makes a decision to proceed with a take-over and continues to use the EIS to monitor the impact on KPIs including the share price and P/E ratio.

Access to the EIS is restricted to a small number of users given the sensitivity around such confidential information. The directors use a ‘dashboard’ which provides highly summarised company-wide metrics and live market-data about competitors.

Tactical information

Tactical information is used to decide how the resources of the organisation should be used, and to monitor how well they are being used. It is useful to relate tactical information to the sort of information that is contained in an annual budget. A budget is planning at a tactical management level, where the plan is expressed in financial terms.

The general features of tactical information are as follows:

- It is often information about individual departments and operations.
- It is often in summary form, but at a greater level of detail than strategic information.
- It is generally relevant to the short-term and medium term.
- It may be forward-looking (for example, medium-term plans) but it is often concerned with performance measurement. Control information at a tactical level is often based on historical performance.
- The data that is analysed to provide the information comes from both internal and external sources (from sources inside and outside the organisation), but most of the information comes from internal sources.
- It is often prepared on a routine and regular basis (for example, monthly or weekly performance reports).
- It consists mainly of quantified information.
- There may be some degree of uncertainty in the information. However, as tactical plans are short-term or medium-term, the level of uncertainty is much less than for strategic information.

Illustration: Tactical information for performance management

A management information system is used to prepare monthly management accounts for divisional heads. The management accounting team prepares monthly accounts during a 4-day window immediately after each calendar month-end. This allows sufficient time for processing accruals, pre-payments and any other manual journals.

The management accounting system resides on the company's central mainframe. The system is accessed by authorised finance staff only via their desktop computers which are connected to the local area network.

The management accounting system reports underlying data directly from the financial accounting system.

Divisional heads use the monthly management accounts to review actual performance in their division versus budget and revise their annual forecast as each month of the accounting year progresses.

The key metrics they focus on include:

- Divisional return on investment
- Divisional return on capital employed
- Divisional gross and net profit margins
- Divisional headcount
- Divisional payroll expenses

Operational information

Operational information is needed to enable supervisors and front line managers to organise and monitor operations, and to make on-the-spot decisions whenever operational problems arise.

Operational information may also be needed by employees, to process transactions in the course of their regular work.

The general features of operational information are as follows:

- It is normally information about specific transactions, or specific jobs, tasks, daily workloads, individuals or work groups. (It is 'task-specific'.)
- It may be summarised at a work group or section level, but is in a more detailed form than tactical information.
- It is generally relevant to the very short-term.
- It may be forward-looking (for example, daily plans) but it is often concerned with transactions, procedures and performance measurement at a daily level.
- The data that is analysed to provide the information comes almost exclusively from internal sources (from sources inside the organisation).
- It is often prepared frequently, as required for daily operational needs.
- It consists mainly of quantified information. Most of this information is 'factual' and is not concerned with uncertainty.

Illustration: Operational information for performance management

Zoom limited manufactures low cost furniture. Margins are tight and hence high volume is required to achieve target profit.

The operations manager reviews the production plan at the start of each day that has been automatically generated from the organisation's integrated inventory and ordering system. The report highlights any potential inventory shortages which are then addressed by raising inventory requisition orders.

Zoom maintains a real-time perpetual inventory system which resides on the central mainframe. Data is kept up-to-date as inventory inwards and stores requisitions are recorded immediately by the inventory clerk.

1.6 Qualities of good information

The quality of the performance management information system depends on the quality of the information that it provides. Good information has several characteristics.

Relevance (and volume)

Information has no value unless it has a purpose and is useful. Information must therefore be relevant for its intended purpose.

Some information systems process large amounts of data to provide large volumes of information, but not all of it is useful. There may be more information than a user can actually make sense of. Sometimes, the information generated by an information system might not be entirely relevant, and might not tell the user everything that he or she needs to know.

Information systems may be designed to help the user to find relevant information easily and quickly, for example by searching an expert system (ES) or an executive information system (EIS).

Reliability

Information must be reliable. Reliable information must be:

- Accurate enough for its intended purpose and
- Complete enough for its intended purpose.

Sometimes, this means that information must be 100% accurate and 100% complete. However there are many occasions, particularly with strategic information used by senior management, that information is based on estimates and forecasts, or information is incomplete due to a lack of data.

There are also occasions when the users of information systems have to apply their judgement and reach a decision on the basis of information available. Expert systems are an excellent example of this. An expert system for medicine, for example, might suggest several alternative courses of treatment for a patient, and an expert system for law might indicate several different and opposing legal arguments.

Timely

Information must be available in time for its recipient to make use of it. Information will be used for a purpose. Presumably, there is an 'ideal time' for using the information.

Managers might want items of information quickly, so that they can make an immediate decision. Many information systems, such as expert systems and executive information systems, offer immediate responses to input queries.

Speed of access to data (and the speed of a system in responding to queries) is often regarded as a desirable feature of an information system.

User confidence

Users must have confidence in their systems and the information that they provide. Information must therefore be realistic.

At the moment, information systems for business have not been designed that are capable of removing the need for management judgement in making decisions. However, information does not need to be 100% accurate for users to have confidence in it. The user of information needs to know how reliable the information may be, and (as suggested above) that the information will not be completely wrong.

The value of information must be more than its cost

Information should not cost more to obtain than the value it provides.

- Some information systems may provide information at a level of detail (or accuracy) that is not required, when it would be cheaper to provide less detailed (or less accurate) information to meet the user's requirements.
- Some information systems may provide additional information that is not used at all.
- An information system may provide information that is used, but the benefits from using the information are less than the cost of obtaining it.

1.7 Ensuring reliability and accuracy of information

When a performance management system is designed, one of the issues facing the system designer is how to ensure that the quality of the information will be good enough to meet the requirements of the users. In particular, information must be reliable and users must have confidence in the information that the system provides.

The reliability of an information system depends on three main factors.

- The **completeness** of the information. Information should be obtained from the appropriate sources, and it needs to be sufficiently complete. A user cannot rely on information when significant items of data have not been taken into consideration.
- The **Timeliness** of the information. For some information systems, information needs to be up-to-date. For example, an on-line theatre booking system or airline travel booking system must ensure that the data about seat availability is always completely up-to-date for users of the system.
- **Accuracy**. The information needs to be accurate enough for its purpose. The accuracy of information in a computer system can be improved, if required, by trying to reduce the amount of errors in the input data.
- **Data validation** checks can be written into the system software. These carry out checks on input data and reject (refuse to accept) items for processing where there is a logical error in the input.
- **Input documents** can be designed to contain as much pre-printed material as possible, to reduce the number of errors in preparing the documents. Similarly, when data is input by keyboard and mouse, data screens can be designed to include as much pre-set data as possible, to reduce the risk of keying errors by the computer operator.

1.8 Accessibility of information

Business information in performance management systems should also be readily-accessible. The user of information should be able to find it when he or she needs to use it.

With developments in information technology and information systems, it is now common to think of 'accessible' information as information that can be obtained immediately, on demand. In particular, databases can make large amounts of information immediately available, especially when they are accessible through a computer network.

Even 'old' transaction data can be made accessible through storage on an electronic medium.

1.9 Security of information

Although information should be accessible to authorized users, it should also be kept secure, particularly from access by unauthorized users.

Methods of keeping data secure might include:

- **Physical security**. Access to computer centers may be restricted security measures such as identity cards and entry cards.
- **Software security** to prevent (or detect) unauthorized access, using passwords, encrypted data, firewalls, and so on.
- **Anti-virus software**, to prevent the corruption or destruction of data and software by hackers.
- The use of **back-up files**, to ensure that data is duplicated or can be re-created. Back-up files ensure that the data will not be lost if the main copy of a file is physically lost or destroyed, or becomes unreadable.

2 SOURCES OF INFORMATION

Section overview

- Information from internal sources
- Information from external sources
- Organising a system for providing external information
- Limitations of external information
- Costs of information

Performance measurement systems, both for planning and for monitoring actual performance, rely on the provision of relevant, reliable and timely information. Information comes from both inside and outside the organisation.

Traditionally, management accounting systems have been an information system providing financial information to managers from sources within the organisation. In large organisations, management accounting information might be extracted from a cost accounting system, which records and analyses costs.

With the development of IT systems, management information systems have become more sophisticated, using large databases to hold data, from external sources as well as internal sources. Both financial and non-financial data are held and analysed. The analysis of data has also become more sophisticated, particularly through the use of spreadsheets and other models for planning and cost analysis (for example, activity based costing).

2.1 Information from internal sources

A control system such as a management accounting system must obtain data from within the organisation (from internal sources) for the purposes of planning and control. The system should be designed so that it captures and measures all the data required for providing management with the information they need.

Potential internal sources include:

- the financial accounting records
- human resource records maintained in support of the payroll system
- production information
- sales information
- staff (through minutes of meetings etc.)

The essential qualities of good information are as follows:

- Information should be relevant to the needs of management. Information must help management to make decisions. Information that is not relevant to a decision is of no value. An important factor in the design of information systems should be the purpose of the information – what decisions should be made, and what information will be needed to make those decisions?
- Information should be reliable. This means that the data should be sufficiently accurate for its purpose. It should also be complete.

- Information should be available in a timely manner. In other words, it should be available for when it is needed by management.
- The cost of providing the information should not exceed the benefits that it provides. The key factor that limits the potential size of many information systems is that the cost of obtaining additional information is not justified by the additional benefits that the information will provide.

In designing a performance measurement system, and deciding what information is required from internal sources, these desirable qualities of good information should influence the design of the system.

Traditionally, management accounting systems have obtained internal data from the cost accounting system and costing records. In many organisations, IT systems now integrate costing data with other operational data. This means that data is available to the management accounting system from non-accounting sources.

Example:

An information system might be required to provide information about the profitability of different types of customer.

The starting point for the design of this information system is the **purpose** of the information. Why is information about customer profitability needed? The answer might be that the company wants to know which of its customers contribute the most profits, and whether some customers are unprofitable. If some customers are unprofitable, the company will presumably consider ways of improving profitability (for example, by increasing prices charged to those customers) or will decide to stop selling to those customers.

The next consideration is: What data are needed to measure customer profitability? The answer might be that customers should first be divided into different categories, and each category of customer should have certain unique characteristics. Having established categories of customer, information is needed about costs that are directly attributable to each category of customers. This might be information relating to gross profits from sales, minus the directly attributable selling and distribution costs (and any directly attributable administration costs and financing costs).

Having established what information is required, the next step is to decide how the information should be 'captured' and measured. In this example, a system is needed for measuring each category of customer, sales revenues, costs of sales and other directly attributable costs.

The information should be available for when management intend to review customer profitability. This might be every three months, six months or even annually.

2.2 Information from external sources

Managers need information about customers, competitors and other elements in their business environment. The management information system must be able to provide this in the form that managers need, and at the time that they need it.

External information is needed for strategic planning and control. However, it is also often needed for tactical and operational management decisions.

Examples of the external information needed by companies are set out in the table below.

Information area	Examples of information needed
Customers	What are the needs and expectations of customers in the market? Are these needs and expectations changing? What is the potential for our products or services to meet these needs, or to meet them better?
Competitors	Who are they? What are they doing? Can we copy some of their ideas? How large are they, and what is their market share? How profitable are they? What is their pricing policy?
Legal environment	What are the regulations and laws that must be complied with?
Suppliers	What suppliers are there for key products or services? What is the quality of their products or services? What is the potential of new suppliers? What is the financial viability of each supplier?
Political/ environmental issues	Are there any relevant political developments or developments relating to environmental regulation or environmental conditions?
Economic/ financial environment	What is happening to interest rates? What is happening to exchange rates? What is happening in other financial markets? What is the predicted state of the economy?

Sources of external information

Sources of external information, some accessible through the Internet, include:

- market research
- supplier price lists and brochures
- trade journals
- newspapers and other media
- government reports and statistics
- reports published by other organisations, such as trade bodies.

2.3 Organising a system for providing external information

If managers are to be provided with external information by a management information system (MIS), the system must be designed so that it is capable of providing it:

- There has to be a system of data capture. How should information be obtained from the environment and filed within the MIS? How should the data be held within the MIS?
- How should the information be provided to managers? Should it be e-mailed to them? Or should managers be expected to search for the information in the MIS when they need it?
- Should the external information be processed into a usable form for managers when it is captured, or should it be supplied to managers as 'raw unprocessed data'?
- The external information should be divided into strategic information and operational information. Which managers should be provided with the strategic information, and which ones need the operational information?

2.4 Limitations of external information

It is important to recognise the limitations of external information.

- It might not be accurate, and it might be difficult to assess how accurate it is.
- It might be incomplete.
- It might provide either too much or not enough detail.
- It might be difficult to obtain information in the form that is ideally required.
- It might not always be available when required.
- It might be difficult to find.
- It might be out of date.
- It might be misinterpreted.

2.5 Costs of information

Information must be captured, processed and, if it is to be useful, used effectively.

Data capture and processing costs include the cost of the hardware and software used, time spent inputting, analysing and interpreting data (though this might be automated in some instances, for example data input using EPOS systems).

Modern computing equipment makes it very easy to amass huge amounts of data which can be processed into information, but this can bring its own problems:

- The information might not be used in which case the cost of producing it is a waste.
- Important detail might be missed in large volumes of information.

Another important cost is associated with poor decisions based on incomplete information or on a misinterpretation of that information. That could prove very costly indeed.

3 BIG DATA

Section overview

- Meaning
- Using big data

3.1 Meaning

Businesses collect data. The growth of technology has allowed data to be collected in ever increasing amounts.

The term "big data" refers to the huge volume of data available to a business on a day-to-day basis. Big data can be analysed for insights that lead to better strategic decisions.

Doug Laney (an American IT analyst) described big data as having the following characteristics (the 3 Vs):

- Volume. There is a large volume of data available (more than might be handled by a single computer). For example, Google hold huge amounts of data on the search history of customers and the content of web pages viewed.
- Velocity. This refers to the speed at which data becomes available to an organisation. Data streams in at an unprecedented speed and must be dealt with in a timely manner. Data can be collected from a variety of sources including a business's own transactions (e.g. retailer customer loyalty programmes allow retailers to monitor spending patterns of customers), social media, websites etc).
- Variety. Data comes in all types of formats – from structured, numeric data in traditional databases to unstructured text documents, email etc.).

The volume of data available globally is almost unimaginable. Some large companies (e.g. Apple) measure stored information in petabytes.

The following table provides an indication of what this means:

Size	Number of bytes	Approximate number of pages of plan text
Megabyte	1,048,576	87
Gigabyte	2^{30} bytes	895,000
Terabyte	2^{40} bytes	916,000,000
Petabyte	2^{50} bytes	938,000,000,000

3.2 Using big data

Only a small percentage of the huge amounts of data available is actually analysed. The importance of big data is not how much data there is but how it may be used. Analysis might lead to:

- cost reductions;
- new product development;
- smart decision making.

Big data – and the way organizations manage and derive insight from it – is changing the way the world uses business information.

Example:

UPS is a very large logistics company.

It stores a large amount of data – much of which comes from sensors in its vehicles.

UPS launched an initiative called ORION (On-Road Integration Optimization and Navigation) which used on online map data to reconfigure a driver's pickups and drop-offs in real time.

The project cut 85.000.000 miles off routes leading to savings of 8.4 million gallons of fuel.

(UPS has estimated that saving one daily mile per driver saves the company $30 million).

4 RECORDING AND PROCESSING METHODS

Section overview

- Recording data
- Processing methods
- Information systems and access to data
- Difficulties associated with recording and processing qualitative data

4.1 Recording data

There are many different ways of 'capturing' data, and recording it in an information system. Methods of recording data will depend on circumstances, and also on the nature of the data required. For example:

- Records of labour time spent on particular tasks or jobs might be recorded on time sheets or job sheets.
- Records of materials used might be recorded in materials requisition notes.
- Data about customer satisfaction might be captured as records of customer complaints. Alternatively, data might be obtained from market research surveys.

The system of recording data should be made as convenient as possible for the individuals responsible for input of the data to the information system. Where possible, the information system should be designed to minimise the risk of errors.

Data should also be recorded in a form that will allow it to be processed. As a simple example, suppose that records of labour costs should provide for an analysis of these costs into production costs, administration costs and sales and distribution costs. The data about labour costs will have to be recorded in a way that will enable the costs to be divided into their different categories.

4.2 Processing methods

Performance measurement systems should be designed so that data can be processed in a way that meets the requirements of management. There are various ways of processing data, and IT systems enable managers to obtain large amounts of information for different purposes.

- Data might be needed for planning or forecasting. Spreadsheet models and other forecasting models are now commonplace.
- Accountancy software packages, including management accounting packages or modules, can be used to process accounting data.
- E-mail allows managers to communicate information quickly between each other.
- Widespread availability of Wi-Fi connection enables easy connection to the internet when travelling.
- Network technology now allows workers in any location to connect to a firm's system via the internet using virtual private network (VPN) links.

Unified corporate databases combine data from different systems (e.g. purchasing and inventory issues). This can improve control over budgeting, forecasting and planning; reporting etc.

Data warehouses

A data warehouse is a database used for reporting and analysis. The data stored in the warehouse is uploaded from the operational systems. The data may pass through an operational data store for additional operations before it is used in the data warehouse for reporting.

The term "data warehouse" implies a storage function but they do much more than this. The typical data warehouse includes a staging layer that stores raw data, an integration layer where the data is integrated and analysed and moved into a series of hierarchal groups, and an access layer from which users retrieve data.

RFID tagging

Radio-frequency identification (RFID) is the use of a wireless, non-contact system that uses radio-frequency electromagnetic fields to transfer data from a tag attached to an object, for the purposes of automatic identification and tracking. The tag contains electronically stored information which can be read from up to several metres away.

Decreased cost and increased reliability has led to the widespread use of this technology in many applications including:

- Tracking of goods during shipment – UPS customers are able to track dispatches on line
- Inventory control – RFID systems provide accurate knowledge of current inventory. Walmart were able to reduce inventory levels by 30% on some lines.
- Production control – RFID tags attached to cars in process of manufacture can track degree of completion.
- Supply chain management - In the fashion industry an RFID label is attached to the garment at production so that it can be traced throughout the supply chain and removed at the point of sale (POS).
- Tracking of livestock.
- Access into secured areas.
- Travel documents – the technology is used in E-passports.

4.3 Information systems and access to data

Management accounting systems are information systems, and the development of information technology (IT) continues to have a significant impact on management accounting and on:

- collecting data
- storing data and information: (Note: data is unprocessed, whereas information is data that has been processed into something that has meaning or purpose)
- the ability to process data into valuable information

- access to information
- communication of information.

Instant access to management accounting data

Another significant feature of modern IT systems is instant access to information. Information might be held on a central database, and accessible to all authorised personnel through a network connection.

Instant access means that managers do not have to wait for information to come to them, for example in routine reports. They can search for and obtain the information they want at any time. Furthermore, this can be done from any location that has an internet connection.

Remote input

In traditional management accounting systems, data was input to the computer system by specialist staff. There was often a high rate of input errors, and data validation checks were included in the software to reduce the error rate. In many systems, the process of collecting data and input to a computer system was fairly slow.

Modern IT systems often provide for automatic input of data by non-finance operating staff, often with minimal risk of errors. One example is the automatic input of sales data and inventory data at check-out points in stores and supermarkets, using bar codes and automatic bar code readers. Information is available about sales and reductions in inventory at the exact moment that the items are being sold.

Instant access to external sources of data

IT systems also provide for access to external sources of data and information. External data can be obtained from the Internet, either:

- free of charge, for example, from the websites of government departments and public news agencies, or
- through subscription (payments to an external information provider).

A wide range of complex data analysis can be performed with computer software. Many managers can use models for planning and forecasting, including the application of sensitivity analysis to plans and forecasts.

4.4 Difficulties associated with recording and processing qualitative data

Companies should identify their critical success factors and then put in place a series of key performance indicators (KPIs), the achievement of which will result in the company meeting its corporate objectives. The performance measures identified as KPIs might be both quantitative (including financial performance measures) and qualitative.

The use of qualitative performance measures brings certain problems that are not found when using quantitative performance measures.

Qualitative data is subjective and open to judgement. For example, a requirement to achieve a high level of customer satisfaction is an admirable goal but a company needs to decide on how customer satisfaction might be measured in order to identify the success or otherwise of measures taken to improve it.

One approach is to try to express the qualitative measure in a quantitative way (sometimes described as a “quantitative surrogate”).

For example a hotel company might invite guests to complete a short survey after their stay asking them to attach a score to a number of different aspects of their say.

Example:

A **hotel** might ask guests to complete the following questionnaire so as to obtain a measure of the perceived quality of their restaurant.

Please circle a number in each row to indicate how satisfied you were with the following aspects of the hotel restaurant.

	Dissatisfied	Somewhat dissatisfied	Neither satisfied or satisfied	Somewhat satisfied	Dissatisfied
Range of food available	1	2	3	4	5
Quality of food	1	2	3	4	5
Price of the food	1	2	3	4	5
Speed of service	1	2	3	4	5
Cleanliness	1	2	3	4	5
Overall satisfaction	1	2	3	4	5

Hotels often send emails to customers after their visit asking them to complete a short survey on the hotel’s website. Information in this way can be scored and collated automatically.

Possible problems with the use of quantitative surrogates

There are problems with the use of quantitative surrogates. These include the following:

- People may not respond
- The people who do respond will often be biased towards those with a specific point that they wish to make. For example, a guest who has had a particularly bad experience is much more likely to respond that a guest who found everything to be OK.
- Many responders will not circle the extreme scores as a matter of practice.

These problems relate to a business to customer environment. In a business to business environment the supplier is more likely to receive a response from their customers, though the response might be biased downwards if customer is attempting to use the score as a bargaining chip for future price reductions.

Other problems

If qualitative performance can be recorded and processed the results must be communicated to the managers who are responsible for that aspect of performance. It is not always easy to identify the responsible manager. Care must be taken to identify the person responsible correctly. This is particularly important where a manager's reward is based on a qualitative performance measure.

For example, a cleaning manager might lose a bonus if a hotel receives a low score for cleanliness of the rooms on one day out of the month. However, this might have been due to a power cut which prevented effective cleaning. This is a simple example to illustrate that effective performance measurement of individuals must be:

- based on fair targets;
- based on areas of performance that can be controlled by that individual; and
- fairly administered.

This is particularly important when remuneration is linked to performance as a failure to achieve a target due to a perceived injustice and the consequential adverse impact on remuneration can be very demotivating.

5 INFORMATION SYSTEMS FOR PERFORMANCE MANAGEMENT

Section overview

- Types of information system
- Transaction processing systems (TPS)
- Management information systems (MIS)
- Office automation systems (OAS)
- Decision support systems (DSS)
- Executive information systems (EIS)
- Expert systems (ES)
- Knowledge work systems (KWS)

5.1 Types of information system

This section revises the various information systems you encountered in the Management Information paper. In addition you will see examples of appropriate information technology and information systems support that would typically be associated with each type of system, and common information sources.

The systems are:

- Transaction processing systems
- Management information systems
- Office automation systems
- Decision support systems
- Executive information systems
- Expert systems
- Knowledge work systems.

5.2 Transaction processing systems (TPS)

Transaction processing systems (TPS) are systems for processing routine transactions, often in large volumes. They are used extensively in business and government and are an example of an operational information system.

Examples of TPS include:

- Production and purchasing
  - Production planning and control
  - Inventory control
  - Purchasing system
- Accounting system
  - General ledger
  - Receivables / payables systems
  - Payroll
- Sales
  - Sales order system
  - Delivery scheduling system
- Human resources
  - Employee records
  - Training records

The advantages of transaction processing systems, compared with manual systems for processing transactions, are:

- The ability to handle much larger volumes of transactions
- Cost-effectiveness
- Much faster processing
- Fewer errors in processing
- Efficiency in storing/filing data records.

Illustration: TPS – Inventory

Inventory in a small business

- The inventory system in a small business may be run on a stand-alone computer residing in the stores warehouse. This would be manually updated by the stores clerk entering information from goods received and goods despatched notes (GRNs and GDNs) having first checked that an order had actually been made for the goods.
- Duplicate GRNs and GDNs are handed to the accountant for entry into the general ledger which resides on a separate computer.
- The two systems are then reconciled monthly by the accountant.

Inventory in a large business

- Compare the above to an integrated system used in a much larger organisation. This would likely involve a perpetual inventory system located on a centralised computer system connected to various client computers across a local area network within the organisation.
- When the inventory records are updated in the stores warehouse the inventory module automatically updates trade receivables, purchases and inventory accounts in the general ledger.

5.3 Management information systems (MIS)

Management information systems (MIS) provide information to management, of a routine or non-routine nature, by analysing data and converting it into organised information.

MIS provide management information in regular or routine reports, which management can use for planning and controlling activities.

In many cases, management information is produced from systems that also process transactions. For example, sales reports can be produced from a sales order processing system, and financial reports can be produced from a general ledger system.

Some management information systems take data from other sources, and provide reports for management. Examples are:

- ❑ **Budgeting systems**, which are used to prepare budgets
- ❑ **Budgetary control systems**, that compare actual results with a budget and report the differences as variances
- ❑ Cost accounting and management accounting systems
- ❑ **Sales analysis** reporting systems.

Management information systems provide structured information, and can help managers to make fairly routine or standard decisions. They are not well-suited for assisting managers with more complex decisions.

MIS may also rely mainly on data obtained internally, from within the organisation, rather than on external data obtained from outside sources.

Illustration: MIS

MIS in a small organisation

- ❑ The management information system may be little more than a collection of spreadsheets that are manually updated by the accountant whenever they have time.
- ❑ Information would be extracted from the general ledger using standard queries from a standard 'off the shelf' accounting package and then manually entered into the spreadsheets.
- ❑ Given the high manual element there is a greater risk of errors in the subsequent MIS shared with management.

MIS in a large organisation

- ❑ In a large organisation the MIS may have been programmed by a dedicated IT team, or at least involve a much more complex accounting package.
- ❑ A dedicated accountant (or team of accountants) would have written some queries that extract standard reports on a monthly basis for timely reporting to management.
- ❑ The system would integrate both financial accounting and management accounting to help ensure accuracy and consistency.
- ❑ The system is more likely to reside on a central mainframe, or server, and be linked to the management accountant's 'client' machine over a local area network.

5.4 Office automation systems (OAS)

Office automation systems, as the name suggests, are systems that automate office processes. They include:

- Word processing systems
- Database systems for desk-top PCs
- Electronic filing systems
- Systems with e-mail facilities and a link to the internet
- groupware systems.

Illustration: word processing

Word processing systems are typically simple, localised operational programmes that reside on an individual employee's PC or laptop computer.

The underlying data files might be saved:

- locally on the same physical device
- locally in a peripheral storage unit – e.g. USB flash stick
- online in the 'cloud' (needs an internet connection)
- on a central computer accessed via LAN link.

Data might be entered into a word processing system in a number of ways:

- manually
- automatically through an optical character reader
- from another file

5.5 Decision support systems (DSS)

Decision support systems (DSS) are systems that provide support for managers in making decisions for unstructured or semi-structured problems. (In comparison, MIS can help managers with reaching decisions for structured problems.)

A DSS consists of data analysis models, and may have access to a database to extract data for analysis. It should provide the user with information about a number of different alternatives or different possible outcomes.

Models in a DSS will therefore provide statistical analysis or the facility for scenario planning. For example:

- A DSS may include a forecasting model that allows the user to prepare forecasts from available data, and to consider possible variations in the forecast using sensitivity analysis or statistical analysis
- A DSS may provide a planning model that allows the user to prepare draft plans and then carry out sensitivity analysis on the data. (A spreadsheet model is a form of DSS.)

Illustration: DSS

It can be argued that a DSS would be classified as a tactical or strategic system depending on whether it is used to support middle-management in making a short-medium term tactical decision (e.g. switching from holding inventory to a just-in-time system) or senior management making a long-term strategic decision (e.g. whether to close a particular branch).

Decision support systems are common in operational research. A good example might be simulating the baggage handling system at an airport. The system is used to simulate different phasing of baggage handling procedures to establish the best operational setup.

DSS are normally features of larger organisations. They would blend a combination of information from the general ledger plus extra externally sourced information relevant to the specific decision being addressed.

5.6 Executive information systems (EIS)

Executive information systems (EIS) are information systems for senior executives. They have access to data from sources both inside and outside the organisation. The system has the ability to analyse the data in a variety of ways, so that senior executives can obtain selected information on demand, analysed at a suitable level of detail. EIS are also called executive support systems (ESS).

A key feature of an EIS is that it provides information to executives in summarised form, for example information about performance in relation to critical success factors and key performance indicators, but which also allows the user to 'drill down' to extract more detailed information.

Although information can be presented to executives in the form of tables, or even narrative, EIS incorporate the facility to present information in a more user-friendly form, for example in the form of graphs, bar charts or pie charts.

Illustration: EIS

An EIS may allow an executive to obtain summary balance sheet and income statement information, based on the most current data held in the general ledger. This will allow them to:

- compare actual financial performance with targets (note: if the executive needs more financial information he or she may be able to 'drill down' to find it e.g. more detail about inventory or more detail about trade receivables)
- review overall risk exposure on a daily basis

Similarly, an EIS may provide an executive with current data about sales volume, which can be compared with targets. If actual sales are below target, the executive can drill down into the sales figures to find out more details – for example, which products are selling less than target, or which sales regions are performing badly.

External data for an EIS may be sourced from financial information providers (for example, information about share prices, exchange rates, interest rates and so on). This is normally done through an automated live data feed from a dedicated market data provider such as Reuters.

5.7 Expert systems (ES)

Expert systems are a type of artificial intelligence system. The purpose of an expert system is to provide expert information to the system user.

An expert system covers a specific area of expertise. It allows a user to interrogate the system to obtain information, advice or possible solutions to a problem. Examples of expert systems are legal advice systems, investment advice systems, medical diagnosis systems and tax advice systems.

An expert system has several components:

- A knowledge base, that holds all the facts and rules relating to the area of expertise
- A knowledge acquisition program, through which the knowledge base is kept up-to-date
- An 'inference engine', which is the software that responds to inputs from the user, and draws on the knowledge base and applies reasoning to provide a response

An explanation program that provides an explanation of the reasoning that has been used by the system to reach its conclusion and produce its advice.

Expert systems can be used by experts to reinforce their opinion or give them suggestions. For example:

- Professional lawyers can use a legal expert system to obtain information about relevant legislation or court decisions.
- Similarly, doctors can use a medical expert system to obtain a diagnosis, or several possible diagnoses, of a patient's medial symptoms.
- An investment analyst can use a financial investment expert system to find suitable investments to recommend to a client.

Illustration: Expert systems

An expert system used to help diagnose patients in a public hospital is likely to be developed by a dedicated IT development team. The programme and database will be maintained in a central server which is then accessed through client terminals by individual doctors. More data is entered into the database as new cases evolve.

5.8 Knowledge work systems (KWS)

Knowledge work systems are systems that are used to create new knowledge or integrate new knowledge into an organisation. They include CAD systems and virtual reality systems.

Illustration: KWS

A team of designers and architects operate a virtual company as they live in different cities across the world. The company has a knowledge work system which is located on a database in a central computer in Lagos.

Whenever the individual architects discover new materials or working practices they enter details into the KWS so that the new knowledge is accessible across the world to fellow employees in the same organisation.

The system issues 'alerts' based on new entries in the system. Employees set their alert preferences to ensure they only receive relevant knowledge updates.

6 THE EFFECT OF IT ON PERFORMANCE MANAGEMENT

Section overview

- IT systems for providers of services
- IT systems and performance management
- IT systems and competitive advantage
- e-business and its implications for performance management

6.1 IT systems for providers of services

The service industry is made up of organisations that deliver services to consumers. The individuals who make up this industry are hired to perform tasks.

Most performance management techniques were developed for manufacturing organisations but might often be useful for service companies.

Both types of organisation turn inputs into outputs:

- A manufacturing company uses labour and other inputs to transform raw materials and components into finished products which it sells.
- A service company does not produce/sell products but provides a service.

Both types of company need to determine the costs of output for planning (e.g. activity levels) decision making (e.g. pricing) and control.

There are a number of performance management techniques which have been developed to link the cost of inputs to the costs of production. These can be used in the service industries also.

For example an accountancy firm provides a variety of services. The costs of the firm can be assigned to cost drivers (e.g. an hour of each staff types' time) and the cost of each consultancy contract found by multiplying time spent by hourly costs. This is based on ABC principles which identify cost drivers and job costing which assigns costs to individual jobs.

IT systems and service providers

IT systems can improve the quality of service in a number of different ways.

The service provider has instant access to the customer's files or to other key information. Instant access means that a customer's requests can be dealt with immediately. This makes it possible, for example, to sell and renew insurance policies by telephone.

For companies that provide services (rather than manufacturing goods), IT systems can make substantial improvements in the quality of service provision. A key feature of many services is the contact between a representative of the company (the service provider) and the customer. This may be face-to-face contact, or contact by telephone or even e-mail or text message.

The Internet often makes it possible for customers to compare the products or services of different suppliers, and to make an informed choice about which supplier to buy from. It may therefore be important for companies to provide extensive information to customers on their web site, to help them make their purchase decisions.

Some services can be provided through IT systems. In some cases, the customer is given the opportunity to take control over his own service provision. For example, customers can book seats on air flights and at theatres using the Internet and the service provider's web site or download media items (music and film) through the Internet. Immediate service provision, made possible by IT systems, is likely to increase customer satisfaction with the service.

6.2 IT systems and performance management

Performance management systems are information systems, and the development of information technology (IT) continues to have a significant impact on performance management and on:

- Collecting data
- Storing data and information: (Note: data is unprocessed, whereas information is data that has been processed into something that has meaning or purpose)

  The ability to process data into valuable information
- Access to information
- Communication of information.

Instant access to performance management data

Another significant feature of modern IT systems is instant access to information. Information might be held on a central database, and accessible to all authorised personnel through a network connection.

Instant access means that managers do not have to wait for information to come to them, for example in routine reports. They can search for and obtain the information they want at any time. Furthermore this can be done from any location that has an internet connection.

Remote input

In traditional performance management systems, data was input to the computer system by specialist staff. There was often a high rate of input errors, and data validation checks were included in the software to reduce the error rate. In many systems, the process of collecting data and input to a computer system was fairly slow.

Modern IT systems often provide for **automatic input of data by non-finance operating staff**, often with minimal risk of errors. One example is the automatic input of sales data and inventory data at check-out points in stores and supermarkets, using bar codes and automatic bar code readers. Information is available about sales and reductions in inventory at the exact moment that the items are being sold.

Instant access to external sources of data

IT systems also provide for access to external sources of data and information. External data can be obtained from the Internet, either:

- Free of charge, for example, from the web sites of government departments and public news agencies, or
- Through subscription (payments to an external information provider).

A wide range of complex data analysis can be performed with computer software. Many managers can use models for planning and forecasting, including the application of sensitivity analysis to plans and forecasts.

6.3 IT systems and competitive advantage

In a highly competitive market, service providers are continually looking for ways to manage their costs and increase productivity.

IT systems may be able to give one business a **strategic advantage (competitive advantage)** over its rivals. The efficiency of IT systems can improve the quality of administration, production and service to customers – and so provide better value for customers, for example by reducing costs or providing a faster service.

Even if an IT system does not provide a competitive advantage, however, a business may need to have efficient systems to avoid being at a competitive disadvantage. A business needs to invest in IT to keep up with what rivals are doing.

Significantly, IT systems can create a competitive advantage by providing management with better information. In this respect, a well-designed performance management system will provide a competitive advantage.

Management should keep their IT systems under continual review, and:

- Be aware of new developments in IT systems and new opportunities for exploiting IT
- Review existing systems to ensure that they are of a high quality and are operating effectively and efficiently
- Monitor the use of IT systems by competitors, and be prepared to respond to any initiatives in IT that competitors introduce.

6.4 e-business and its implications for performance management

The objective of e-business is to increase the competitiveness and efficiency of an entity by using electronic information exchanges to improve processes. E-business does not simply involve automating existing processes. Processes should be radically redesigned by e-business methods so that they become more efficient and create added value. E-business opportunities can alter the strategic position of an entity and provide different strategic choices.

- E-business can change the nature of the market place in which goods and services are bought and sold. For example, it encourages the globalisation of markets and the buying and selling of items in the internet.
- E-business also changes the nature of the relationships with suppliers and customers.

E-business significantly extends the volume and scope of information accessible to organisations for performance management purposes.

7 CRITICAL SUCCESS FACTORS

Section overview

- Definition of critical success factors (CSFs)
- CSF methodology
- Measuring achievement: key performance indicators (KPIs)
- CSFs and IS/IT strategy
- Sources of CSFs for information systems
- Using IS/IT to monitor CSFs and the achievement of targets

7.1 Definition of critical success factors (CSFs)

Definition: Critical success factors

Critical success factors (CSFs) are 'factors so critical to success that if the objectives associated with those factors are not achieved, the organisation will fail, possibly catastrophically'.

They have also been defined as 'the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation'.

7.2 CSF methodology

CSFs have been associated with business strategy and strategic planning for many years. It is a 'top-down' approach that begins with the main long-term strategic objective of the organisation.

From this overall strategic objective, five or six 'higher level' goals or objectives are decided. These are objectives that will have to be met in order to achieve the overall objective for the organisation.

Having identified five or six higher level objectives, the analysis is taken down to the next level of detail. For each higher level objective, a small number of critical supporting objectives are identified. These are objectives that will have to be met in order to meet the higher-level objective.

This approach to identifying success factors can be taken down to the lowest level of management and planning. However, all the factors that are identified as 'critical' will have to be met. Failure to achieve any of them will threaten the ability of the organisation to achieve its long-term strategic objective.

Example: CSF

A government might decide that the main objective of its education policy should be to provide every pupil in state-run schools with the best-possible IT facilities to support their studies.

Having established this as the main objective of policy, the following two high-level CSFs might be identified:

- ❑ CSF1: To provide high-quality software to schools.
- ❑ CSF2: To increase the availability of IT facilities in schools

7.3 Measuring achievement: key performance indicators (KPIs)

In strategic planning, CSFs are associated with key performance indicators (KPIs).

- For each CSF, there must be a way of measuring whether the required objective or target has been met.
- This measure of performance (a key performance indicator) can be used to set planning targets, and to monitor actual performance by comparing actual results with the target.

CSFs and KPIs may be decided by planning teams of managers, who discuss different possible CSFs and KPIs, and reach agreement on which success factors are critical (and if appropriate, ranking them in order of priority).

Example: KPI

The main objective of a commercial company may be to maximise the wealth of its shareholders. A CSF of a commercial company might therefore be 'to achieve a minimum volume of annual sales to earn a sufficient return on investment'.

A suitable key performance indicator might be the annual sales volume, or possibly a target share of the market. Having identified what the KPI should be, strategic targets should be set for the CSF and actual achievements should be compared with the target.

The impact of internet technologies on KPIs

The volume and scope of information now readily accessible to organisations is simply immense. The potential to benefit from performance management with access to such vast information sources is also significantly improved. There are two components to this:

- Increased access to market data;
- The ability to measure the impact that e-business has on an organisation.

Some examples of KPIs relating to e-business could include:

Example	KPI
Supply chain	Reduction in average lead time following implementation of EDIs (electronic data interchange)
Product	Proportion of customers selecting electronic invoicing rather than paper invoicing
Price	Impact of price change on sales volume
Place	Profitability by supply channel
Promotion	Profitability by promotion method
Physical evidence	Proportion of customers who book and pay in advance via the website rather than call the reservations manager
People	Customer satisfaction survey results collated by email
Process	Average number of 'website hits' per sale
CRM	Net profitability by client (using activity-based costing)

7.4 CSFs and IS/IT strategy

The idea of identifying CSFs as a basis for developing IS/IT strategy was popularised initially in the late 1970's.

There are two separate issues to consider:

- Critical success factors for IS/IT strategy, and the IS/IT systems needed to achieve CSF targets, and
- The extent to which IS/IT systems can support the use of CSFs by an organisation.

Existing IS/IT systems may have to be modified, or new systems may have to be developed, to enable an organisation to achieve the critical factors necessary for success. The process of identifying CSFs and KPIs for information systems is similar to the process described above for business strategy in general.

Some examples of high-level IS/IT-related CSFs are shown below.

Entity type	CSF	KPI
Bank	Money transmission systems must always be in operation. Immediate back-up systems must always be available in case of breakdown or damage.	KPIs can be set in term of numbers of back-up computers and the existence of an emergency back-up network.
Retail company	We must have a web site with an e-commerce facility.	Target date for the introduction of an operational e-commerce facility.
Manufacturing company	Customer orders must be dealt with quickly: lead times must be no longer than those of our main competitor.	Target 'lead time' for handling customer orders, to be achieved by the introduction of an upgraded sales order IT system.

At a lower level in the hierarchy of objective setting, some success factors for IS/IT might also be as follows:

Entity type	CSF	KPI
Company with automated telephone call handling system for customers	Customer calls must be dealt with quickly; otherwise we will lose business.	- an average time for a customer to be in the call-handling system - a maximum target percentage of customers who terminate the call without having been given service.
Company with database for staff dealing with telephone queries from customers	The system must be in operation whenever customers call, so that their queries can be dealt with.	KPI might be a target for a maximum percentage 'downtime', when the system is not functioning due to computer failure.

An examination question may require you to identify critical success factors for an organisation, and to suggest how modifications to existing IS/IT systems, or new IS/IT projects, may help the organisation to achieve these CSFs.

7.5 Sources of CSFs for information systems

There are four general sources from which CSFs originate. They are:

- The **industry** in which the entity operates. There may be something about the industry that creates a factor critical to success. Banks, for example, must have IS/IT systems in order to provide their services.
- The **company itself** and its situation within the industry. For example, an insurance company may specialise in selling insurance policies on-line. The efficiency of its IS/IT system will be more critical to its success than for rival insurance companies that rely much less on on-line sales.
- The **environment**. Examples of environmental factors may be changing consumer tastes and trends, the state of the economy, and political factors. The effectiveness of an IS/IT system may be critical, for example, to enable an organisation to meet legislative requirements or regulations.
- **Temporary factors that may give cause for concern**, such as high levels of errors, cancelled orders, customer complaints, inaccurate inventory records and so on.

An organisation needs to be aware that new critical factors may emerge, and if they do, it is important to recognise them quickly before the problem gets too big. Sources of warnings about a new crisis may be:

- Customers (changes in the level of satisfaction or dissatisfaction)
- Complaints handled by customer services department
- Major competitors (and new initiatives that they may take to gain competitive advantage)
- Accounting reports (and changes in profitability and cash flows).

7.6 Using IS/IT to monitor CSFs and the achievement of targets

It has already been shown that targets should be set for each CSF, and actual performance should be monitored by comparison with the target. IS/IT systems can support the use of CSFs by an organisation because they can be used to monitor performance, and measure performance indicators.

Senior management could make use of an executive information system (EIS) to monitor performance and CSFs at a high level. An EIS can be designed that allows senior executives to monitor actual performance in relation to selected CSFs, so that the executive is always in a position to obtain up-to-the-minute information.

However, IS/IT systems can be used to monitor and measure key performance at all management levels within an organisation – at a strategic level, at a tactical level and at an operational level.

	Strategic	Tactical	Operational
Examples of CSFs	Expand the business to become a global company. Increase market share. Increase profitability.	Be competitive on prices. Create loyal customers. Acquire and retain skilled staff.	Speedy delivery to customers. Keep customers satisfied. Keep costs under control. Maintain quality standards.
Examples of KPIs	Target rate for annual growth in business in foreign markets. Target share of the market. Target annual growth in profits.	Selling prices not to be higher than for any rival product. Targets for repeat orders or frequency of repeat orders. Targets for recruitment and training.	Deliver to customers within 48 hours of order. Target maximum level for items returned. Target maximum rate of complaints. Efficiency targets. Targets for maximum error rates.
IS/IT system support	Executive information systems. Systems to collect and analyse market size and company sales. Financial information systems.	Systems for collecting and analysing market data. Sales order system information. HR system information.	Order processing system. Customer service system. Accounting system. Production control system.

8 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter, check that you can:

- Describe the types and levels of information used in performance management information systems
- Describe the sources of information including big data
- Explain methods of recording and processing information
- Explain, with examples, the common types of performance management systems and how they may be used for managing performance
- State the qualities of good information and explain concepts of reliability, accessibility, accuracy and security of information
- Summarise the impact IT has had on performance management with respect to providers of services and management accounting
- Describe the impact IT systems have on competitive advantage
- Define critical success factor (CSFs) and key performance indicator (KPIs)
- Explain the link between CSFs and IS/IT strategy
- Describe how IS/IT is used to monitor CSFs in the achievement of targets

Skills level
Performance management

CHAPTER 30

Implementing performance management systems

Contents

Aim

Performance management develops and deepens student's capability to provide information and decision support to management in operational and strategic contexts with a focus on linking costing, management accounting and quantitative methods to critical success factors and operational strategic objectives whether financial, operational or with a social purpose. Students will be expected to be capable of analysing financial and non-financial data and information to support management decisions.

Detailed syllabus

F	**Performance and management systems**		
	2	Evaluate and advise management on suitable approaches that may be used to manage people, issues and change when implementing performance management systems.	
	3	Discuss the accounting information requirements and analyse the different types of information systems used for strategic planning, management control and operational control and decision-making.	
	4	Discuss roles of accountants in:	
		a	Project management;
		b	Project planning; and
		c	Project control methods and standards.

Exam context

Organisations face a number of challenges when implementing new information systems. This chapter provides the context for various implementation considerations and explains how change can be managed effectively.

By the end of this chapter, you should be able to:

- Describe the impact of IT on employer/employee relations
- Discuss the general problems associated with implementing new systems
- Understand what drives the success or failure of information systems
- Explain the nature of common user resistance to new information systems and change
- Describe Lewin's 'Three Stage' change process
- Discuss tactics for managing successful change
- State key project monitoring and control tasks
- Briefly explain the role of the project manager in managing the team
- Briefly explain the role of the accountant in projects

1 IMPLEMENTING PERFORMANCE MANAGEMENT SYSTEMS

Section overview

- Accessibility
- Supporting the tasks of the manager

1.1 Accessibility

A key factor in the design of a performance management system is the way in which information is to be made available and accessible to the intended users.

Individuals with performance management responsibilities must have information to do their work. IT systems make it possible, in principle, to provide individuals with enormous amounts of data and information. There could be a risk that an information system makes so much information available to users that there is 'information overload'. Individuals may receive so much information that they do not necessarily know what are the most important and relevant items, and so they do not make the best use of the information they are given.

Performance management systems should be designed in a way that makes information accessible in a convenient and helpful way. Users should have ready access to the information they use the most often. They may in addition need access to other information occasionally.

Important factors to consider in the design of a performance management system are:

- What information is needed by individuals using the system?
- Why is the information needed or useful? What will the user do with it?
- How often is it needed?
- Where will the information be obtained from? In other words, how should the source data be captured?
- How should the information user be able to access the information?

For essential and important items of information, it should be the responsibility of the system designers to make sure that individuals are provided with the information.

- Information or data that is essential to carrying out a task must be provided to the user in a convenient way. For example, individuals who use an IT system for operational variance control must be able to access the data they need to drill down into individual variances. Gaining access to this information should be made as easy and convenient as possible for the user.
- Similarly, information that individuals will use often should also be made easily accessible.

When the information requirements of individuals are less predictable, or less frequent, a system might make the information accessible to users, but then leave the responsibility with the user for finding it when it is needed.

For example, intranets have made it possible to provide enormous amounts of data to employees within an organisation. However, there is so much information available that it might become the responsibility of the recipient to make sure that he gets the information that he wants, rather than the responsibility of the provider of information to make sure that it reaches individuals who might need it.

1.2 Supporting the tasks of the manager

Introduction

According to 'traditional' theory of organisation and management, the tasks of management are to:

- Set targets and make plans for achieving those targets
- Communicate
- Organise activities
- Co-ordinate activities
- Provide leadership or direction
- Motivate others
- Monitor performance
- Take control measures to improve performance.

Performance management

The new IS/IT performance management systems will be used by managers to manage the performance of the organisation, and individuals and work units within it.

The requirements for the new performance management system include:

- Clear objectives, expressed perhaps as critical success factors
- Targets for each objective, expressed perhaps as key performance indicators
- Using these key performance measures to measure actual performance
- Providing managers with a comparison of actual performance with the target, or a comparison of target performance with current forecasts.

IS/IT systems can be designed to provide managers with the key performance measures that they should monitor. For example, executive information systems can be designed so as to provide senior managers with:

- Readily-available information about current performance or historical performance in selected key areas, and
- A facility to 'drill down' to analyse aspects of performance in more detail, if required.

Quality of planning and control

The information provided by the performance management system can improve the quality of planning and control. For example, decision support systems can be used for forecasting and preparing plans. Sensitivity analysis and scenario testing are made much easier with computer models, and these improve planning by testing the assumptions that have been used in preparing the plans and testing the robustness of the plans.

However, there is some risk that performance management systems can be used to plan in excessive detail, or to apply excessive control. Management may use performance management systems to demand regular and detailed reports from employees, to the point where employees spend too much time on reporting and too little time on value-adding activities.

2 IMPACT OF IT ON EMPLOYER/EMPLOYEE RELATIONS

Section overview

- IT systems and organisation structure
- The effect of home working on an organisation
- E-mail and work practices
- De-skilling of operatives
- Socio-technical system design

2.1 IT systems and organisation structure

IT-based performance management systems can affect the relationship between employees and management, and between employees and the organisation they work for.

IT-based performance management systems make information more easily accessible. As a result of improved communication and more convenient methods of communication, it is often possible for managers to organise and control the activities of a larger number of subordinates. In other words' the 'span of control' within an organisation may become much wider.

Communication systems, particularly e-mail, allow any individual to contact anyone else. It is possible for a junior employee to send an e-mail direct to the CEO, without the message having to pass through a number of intermediate managers.

In some organisations, there has been some reduction in management hierarchies. Organisations can operate efficiently with a 'flatter' structure (fewer levels of management).

- Although a function of management is to provide information and communication, a large part of this activity can be 'automated'.
- Since employees are able to access information themselves, for example from an intranet database, it is often possible to delegate more responsibility to operating staff, thereby reducing the need for junior management or supervisory staff.

2.2 The effect of home working on an organisation

IT has made it much easier for individuals to work from home. For an organisation, the benefits of home-working include:

- A reduction in the need for office accommodation, and so a saving in costs
- Providing more attractive working conditions for individuals who would prefer to work from home instead of commuting into work: for example, home-working may attract individuals wishing to work from home because of family commitments
- Limited disruption to work in the event of a major transport strike.

There are also disadvantages with home working:

- Management. It may be more difficult to exercise management control over individuals who work in a distant location (from home) rather than in direct contact in an office. For example, it can be difficult to co-ordinate the activities of several different home-workers.
- Employees are likely to feel more distant and isolated, and might need strong self-motivation to work effectively.
- When employees work from home, it is very difficult to make them feel a member of a work team.

Implications of groupware for team-building

The same 'social problem' may arise when groupware is used to help individuals to work together as an electronic team. Groupware allows individuals to function as a 'team' without having to be in close physical proximity to each other. For example, groupware may allow team members to 'meet' and 'discuss' problems electronically, when they are geographically far apart. **This affects working relationships**, because teams linked electronically are unlikely to 'bond' as effectively as a team whose members all work in the same office.

2.3 E-mail and work practices

E-mail has had a profound effect on the way that individuals work with each other.

E-mail, the Internet and mobile telephone technology have all created a culture in which individuals expect immediate access to information and immediate responses to queries. Communication has become much faster, and in many cases, this means that tasks are accomplished more quickly, and organisations operate more efficiently.

Disadvantages of e-mail

Although e-mail improves communication, and so can improve the efficiency and effectiveness of a business, there are some potential disadvantages that need to be controlled, such as:

- E-mail users may receive large amounts of junk mail ('spam' mail), although this can be reduced by anti-spam software.
- E-mails may expose a user's computer system to viruses.
- There can be a security problem, when information is sent to someone by e-mail without checking whether the person is authorised to receive it.
- Employees may get involved in 'chatting' to other individuals by e-mail, for example by exchanging gossip or jokes. Friendly exchanges of this sort can become time-consuming.
- Many users tend to respond immediately to e-mail messages, when their time would be better spent concentrating on more urgent issues in hand. Individuals sending e-mails often expect an immediate response, and are (unjustifiably) annoyed if they do not get a quick reply.
- There is a tendency for users to send e-mail messages without properly checking what they are sending. Messages may contain many typing errors and other mistakes, and the sender may forget to attach documents or may attach the wrong documents.

Some of the disadvantages of e-mail are 'technical' problems, but many are linked to employee behaviour – for example, importing viruses, excessive use of e-mail for chatting, inefficient use of time and prioritising of work.

Using e-mail within an organisation therefore has implications for control over e-mail use, and the ways in which this control should be applied. This affects management/employee relationships.

2.4 De-skilling of operatives

As a result of IT, some labour skills have been lost, or replaced by other skills. The automation of many operations removes or reduces the need for individuals to acquire specialist skills.

De-skilling has occurred in many aspects of work. For example, many engineering skills have been automated. Computers can be used to check for faults in an item of equipment (for example, a car) instead of relying on the skills of individual engineers.

Computer systems are also used to automate procedures, such as handling telephone calls from customers. Telephone operatives may be required to follow the procedures set out on a computer screen when dealing with a customer query or complaint, instead of using their initiative.

Consequences of de-skilling may be:

- For the employer, a saving in employment costs (because employees do not have to be as highly-skilled) and lower training costs
- For the employee, a loss of interest in the work and pride in performance.

2.5 Socio-technical system design

Socio-technical system design is an approach to the design of IT systems that recognises social factors in the operation of the system as well as technical factors. The most efficient IT systems are those that satisfy the needs of the system users for social interaction in the work that they do, as well as performing their 'technical functions'.

Technical aspects

The technical aspects of system design are concerned with identifying the operational requirements for the system, and designing a system to meet those requirements.

Social aspects

The social aspects of system design are concerned with identifying the social needs that a system satisfies for employees that use it. Social needs (or personal needs) include:

- The desire to be a part of a team with other employees, and to communicate with them regularly
- The desire to communicate with other people outside the organisation
- The need to feel that the work requires some skill
- The need for variety in the work
- The need for some authority and responsibility.

A risk with computers is that they isolate individuals, even when working together. Employees may spend too much of their time looking at screens, and not enough time in conversation with others.

However, opportunities for socio-technical system design may well improve over time. Wireless broadband creates the opportunity for individuals to move around with their computer, whilst remaining connected to the Internet. This may provide opportunities for individuals to work together more using their portable or laptop computers. Visual communication methods may be used to create a better sense of familiarity with distant work colleagues.

When 'social features' cannot be built into an IT system, social interaction for employees, and/or a sense of belonging to a team may be provided in other ways. For example, if employees are required to work at computer screens for much of the time, a 'break-out area' may be provided, where they are encouraged to take time out and relax for a while.

An appropriate socio-technical design for an IT system will vary according to the nature of the system. The key point, however, is that IS/IT system design should not ignore the 'human aspect' of how the system will operate and the effect that it will have on its users. A failure to consider the human aspect will probably result in user resistance to the new system and low enthusiasm for the work – and the end result will be an inefficient or ineffective system.

3 PROBLEM AREAS: ORGANISATIONAL IMPACT ANALYSIS

Section overview

- Problem areas when implementing an IS
- Organisational impact analysis

3.1 Problem areas when implementing an IS

When an information system is designed, developed and implemented, several problem areas must be managed carefully.

- The new system should contribute to the economic, financial or operational performance of the organisation. However, when a new system is developed, a 'balance' or compromise must often be made between:
  - a system that meets the user's requirements exactly, and the 'quality' of the system design
  - keeping costs within acceptable limits, and
  - implementing the system within an acceptable time scale.

  It is generally impossible to develop and implement a system of the highest quality within a short time scale and for a low cost.
- The new system is likely to have an impact on organisational and social matters, and in doing so, may arouse strong resistance and hostility form the intended users of the system.

Research has shown that organisational and social issues are significant factors causing new information systems to fail. Even when management have shown an awareness of these problems, their actions are often 'too little, too late'.

A new IS system is 'likely to have a significant impact upon an organisation's culture, structure and working practices'.

Since organisational issues can be a major problem area, it would make sense to consider them carefully at an early stage in an IS project, and try to deal with the problems that are identified.

3.2 Organisational impact analysis

'Organisational impact analysis' is, as its name suggests, the analysis of the likely impact of a new system on an organisation, including cultural, structural and political issues and the effect on working practices. It should be carried out at an early stage of a system development, and should not be left until it is too late to take suitable measures to deal with problems.

Organisational impact analysis should be carried out together with an analysis of the contribution that the new system will make to the organisation, in terms of economic benefit or the achievement of strategic goals.

The following issues should all be considered at an early stage in the project development, up to the implementation of the new system, as well as in a post-implementation review.

Contribution of the system to the economic and strategic goals of the organisation

- There should be a regular analysis of the projected benefits from a new system, to assess whether the system is still expected to meet the organisation's needs within an acceptable time scale and for an acceptable cost.
- The proposed system should conform to the current IS/IT strategy of the organisation. (If it does not, the project should be abandoned, or IS/It strategy should be reviewed and changed.)
- Resources should be allocated to an IS project, so that priority is given to the most important parts of the project. This can be achieved using the **spiral model** approach to system development, which is explained later.
- Management should be aware of the need to think about **business process re-engineering (BPR)** in conjunction with developing a major new system.
- A new system should be designed to support planned future changes in the organisation, and so may need to be flexible in order to allow for these future changes when they occur. Management should not focus on current requirements and ignore planned changes in the future.

Human-related issues

Human-related issues should be considered.

- Training. Management should assess whether a suitable and sufficient training programme has been planned for all users of the system.
- It may be necessary to consider health and safety aspects of using the new system, or ergonomic factors. For example, there may be risks from a new system to the eye sight of users (from working at computer screens), or other aspects of their health. There may be a need for specially-designed chairs for computer users, or a need for regular health check-ups.
- The motivation and needs of system users should be considered. There should be an assessment of how the motivation and needs of the system users will be satisfied (if at all) by the implementation of the new system.
- There should be an assessment of the working styles and the IT skills of the individuals who will be the system users, to decide the implications these may have for system design or training needs.
- Job re-design- There should also be an assessment at an early stage in the system design of whether the new system will change the job specifications of individuals and the relative importance of their work.

All these human-related issues could lead to strong resistance to the new system.

System implementation

Another aspect of organisational impact analysis should be the period of transition from the old system to the new system, when the new system is eventually implemented. Again, this analysis should begin at an early stage in the project development.

- Management should carry out an assessment of how the planned timing of the new system implementation will interact with any other planned changes in the organisation that will be expected at about the same time.
- There should also be an assessment of the likely disruption to the organisation that implementing the new system will cause, and how long this disruption might last.

Organisation structure, culture and power

There should be an assessment of how the new system will have an impact on:

- The structure of the organisation (for example, will the management hierarchy become 'flatter', will there be more centralisation or decentralisation of authority, or will there be job losses or transfers of staff to other work?)
- The culture of the organisation (defined as 'the set of important assumptions, often un-stated, which members of an organisation share in common')
- The balance of power within the organisation. Information (and knowledge) gives power to the individuals who control it. An information system may alter the balance of power. If this can be foreseen, management can anticipate the political implications of introducing the new system.

Organisational impact analysis is needed because it helps management to identify the potential problems that anew system might create, and do something to resolve the problems before it is too late for effective measures.

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4 SUCCESS AND FAILURE OF INFORMATION SYSTEMS

Section overview

- Measuring the success of a new information system
- Reasons why IT projects fail
- Risks in a new system development
- Managing the risks of project failure: external integration, internal integration, formal planning and formal control

4.1 Measuring the success of a new information system

The aim of management should be to ensure as much as possible that each new information system is a success. The factors that determine success for a new IS are as follows:

- **Achieving the objectives of the system**. Did the system achieve its objectives? The system objectives should have been identified clearly when the decision to develop the project was made. Actual achievements should be compared with these objectives.

- **Financial benefits**. A new system may achieve financial benefits, for example from savings in operational costs or from profits resulting from higher sales. The actual financial benefits should be compared with the benefits that were expected when the decision to develop the project was made.
- **User satisfaction**. The success of a new system may be measured in terms of user satisfaction. Is the system helping users with their work? Do users have good things to say about the system?
- **Level of usage**. The success of a system can also be measured by the amount that it is used. High levels of usage suggest that the system is successful – and user satisfaction is high.
- **System availability**. Some new systems have problems with large amounts of down-time, when the system is not operating due to a hardware or software fault. If a requirement of the system is that it should be operational for as much time as possible, the success (or failure) of a system might be measured by the amount of down-time that it experiences.
- **Difficulty using the system**. The success of a system may be assessed according to whether it is user-friendly. A system cannot be a complete success if users have difficulty operating it. The number of calls to the help desk, and the nature of those calls, may therefore be a useful way of monitoring the success – or failure – of a system.

Success of IT development projects

The success factors listed above are the factors that determine the relative success or failure of a new system after it has been implemented. Another factor in the success of a system is the project development –the work carried out to design and develop the system prior to implementation.

Key factors for success of a system development project include:

Aims:

- The project should be clearly defined.

Organisation:

- The project should have sufficient resources.
- Control mechanisms should be in place and used.
- The project must have the support of top management.
- Communication channels should be adequate.
- There should be capability for feedback, and comparing actual progress with the budget or target.
- IT contractors should be responsive to their clients.

People:

- The project manager should be competent
- The project team should be competent.

4.2 Reasons why IT projects fail

The nature of project failure

Failure is the opposite of success. The factors that determine whether a system is a success also determine whether it is a failure. Success and failure are both relative measures – there are differing degrees of success or failure. Some systems are more successful than others. Some are much bigger failures than others.

A new system may be described as a failure when any of the following outcomes occurs:

- The development project is abandoned before the development work is completed, or before the system is implemented.
- The project costs much more to develop than expected (and/or costs much more to operate than expected).
- The new system is implemented, but meets strong user resistance, and the system is not used as much as expected.
- The system is implemented but fails to meet all the user's requirements.
- The system functions inefficiently.
- The development project is completed much later than planned.

Example: new system failure

A brief example of a system failure is a computerised command and control service introduced by the London Ambulance Service some years ago. The new system failed badly, and ambulances sometimes took very long times to reach the scene of an accident. The system cost a large amount of public money, and was claimed to have cost a number of patients their lives.

PEST factors contributing to system failure

The failure of an IT project may also be explained in terms of PEST factors (political, economic, sociological and technological factors).

A study by Bray (1993) identified PEST factors as reasons for the failure of the system.

Political factors- The government had published targets for achieving goals in the health service, in the form of a 'Patients' Charter'. In order to meet the targets in the Charter, deadlines for completion of the LAS project were far too short.

Economic factors- Sixteen companies tendered for the contract to develop the new IT system. The contract was given to the software company that submitted the lowest bid, even though it has a limited track record in developing IT systems.

Sociological factors- Ambulance staff were not given enough training in how the new system operated.

Technological factors- The system did not work as well as it should have done. The system operated slowly, and some telephone calls were lost.

Risks of failure: during development and during implementation

Projects can fail during the design and development work. The causes of failure during system development are mainly related to the issues of meeting user requirements (quality), cost and time scale.

Projects can also fail when they are implemented. Although poor design may be a factor, failure may also be caused by strong user hostility or indifference to the system, and **resistance to change**. Resistance to change is considered in more detail later.

4.3 Risks in a new system development

Three key factors affect the risk for a system development project.

- **Size of the project**. As a general rule, the risk of failure is greater for development projects that are:
  - large, in terms of the amount of people and other resources required to complete it
  - complex
  - expected to take a long time to complete
  - costly (there is a large budget for the project).

  With a large project, there are more things that can go wrong. There are more activities to plan, monitor and control. The individuals involved in the project may not co-operate properly and so fail to work as an effective team. When a large project fails, the cost is usually high.

In contrast, small projects usually involve only a small number of people and a small budget. Even if they go wrong, the consequences are not as great.

- **Structure of the project**- The risk of failure is relatively low if the project has a clear structure. A clear structure depends on having clear user requirements, so that the project can be planned and scheduled with reasonable confidence that the objectives of the system are properly understood. The progress of the project can then be monitored, using project management software and techniques such as critical path analysis and budgetary control.

  In contrast, there is a high risk of project failure if the requirements of the user are not properly understood when the project begins, and the user changes the requirements as the project is being developed.

  Boehm's **spiral model** of project development (described later) was conceived as a way of reducing the risk in badly structured projects, where user requirements are not properly understood when the development work begins.

- **Experience with the technology**- The project development risk is much lower when the project involves technology that the project team knows well. Experience with using a technology brings a better understanding of its capabilities.

  In contrast, when a new system involves new technology that the IT team is dealing with for the first time, the technology will be new and unfamiliar. The risk of failure is higher because technical problems may arise for which the IT team cannot find an answer.

4.4 Managing the risks of project failure: external integration, internal integration, formal planning and formal control

A combination of external integration, internal integration, formal planning and formal control can be used to manage the risks in a development project. The choice of risk control methods should depend on the perceived size of the risk in the project.

- **External integration**: external integration refers to measures that are used to improve the relationship and communication between the project development team and the system user (the 'customer' for the system).
- **Internal integration**: internal integration refers to measures taken by the project managers to make sure that the project team have the skills required and work as a cohesive unit.
- **Formal planning and formal control**: these are well-established 'tools' or methods for the planning and control of system development projects.

The following table presents some examples of each of these.

External integration	Internal integration	Formal planning and formal control tools
Regular communications with the user.	Appointing a project manager with relevant skills and experience of the technology.	Critical path charts and critical path progress control.
User representation in the project team.	Appointing team members with suitable skills and experience. Outsourcing work where the team does not have the skills required.	Gantt charts for planning and control. Budgetary control systems. Use of project management software.
Formal procedures for the user to review and approve the system specifications.	Building a cohesive project team. Regular team meetings. Participation of team members in decisions affecting the design and development.	
User involvement in testing.		
External integration methods can reduce risk when user requirements are not properly understood	Internal integration methods are most appropriate when there is a risk because the IT team may lack sufficient experience with the technology.	

5 USER RESISTANCE TO NEW INFORMATION SYSTEMS AND CHANGE

Section overview

- Reasons for user resistance
- People-oriented theory
- System-oriented theory
- Interaction theory

5.1 Reasons for user resistance

Users are often resistant to new information systems. They are reluctant to use a new system and criticise it strongly. When users are opposed to a new system, they are likely to want it to fail.

It was stated earlier that organisational and social issues are a major factor in the failure of IS/IT systems, and some of the reasons for user resistance were considered within the context of organisational impact analysis.

There are three general theories about the nature of user resistance. These are:

- People-oriented theory
- System-oriented theory
- Interaction theory.

5.2 People-oriented theory

This theory concentrates on resistance to a new system because it is seen by individuals or groups of individuals as a threat to something that matters to them, such as their way of working or their social relationships at work.

For example, resistance to a new system may arise from the fact that the system will call for more shift working and 'unsociable' hours of work. A system that allows users to work from home may be resisted by individuals who enjoy going to work because of the people they work with and the camaraderie. Managers may resist a new system for teleconferencing because they prefer the 'old way' of travelling to meet people face-to-face.

5.3 System-oriented theory

This theory concentrates on resistance to a new system because of dissatisfaction with the system design. The user interface with the system may be difficult to understand and use or the users may have difficulty making the system work.

The user interface may be badly designed, so that the screens are not user friendly, and users may not get suitable on-screen prompts to tell them what to do next.

The system may also be badly-designed and does not fully meet user requirements. Clearly, if this happens users will criticise the system and will not want to use it.

5.4 Interaction theory

This theory concentrates on the interaction between the system and its users, and the implications for the role of users in their organisation. It is based on the view that even if the system is well-designed, it could meet resistance from users who are concerned for the effect of the new system on their status or importance at work.

- A new system may be seen as a threat to a person's job – for example, a new robotics system may threaten the jobs of production workers, and new transaction processing systems may threaten the jobs of office workers.
- A new system may be seen as a threat to the status or importance of someone in their job. Skills that individuals used before the system was introduced may be replaced by automated processing – for example, an expert system may take away some of the 'status' of the experts who use it.
- A new system may result in changes to bonus pay arrangements, and users of the system may be worried that their bonus payments will fall as a result of introducing the new system.

Interaction theory is based on the view that even if the system is well-designed, it could meet resistance from users who are concerned for the effect of the new system on their status or importance at work.

6 LEWIN'S 'THREE STAGE' CHANGE PROCESS

Section overview

- Accepting change
- Three stages in the change process
- Unfreeze
- Change (or movement)
- Re-freeze

6.1 Accepting change

Kurt Lewin, a social psychologist, suggested a three-stage process for introducing major change into an organisation. His ideas were based on the view that:

- It is often difficult to persuade people that change is desirable and will have a positive effect
- People need to be persuaded of the need for change before the change is made, and
- After a change has been made, there is a danger that individuals will eventually return to the 'old way of doing things', so that the effects and benefits of the change will soon be lost.

He argued that when a change is planned, it is essential to understand:

- Why the change is necessary – What are the problems with the current way of doing things?
- What opportunities there are for improvement – Why might change be desirable? What benefits will change bring?

These are the keys issues that will persuade the individuals affected to accept the need for change.

6.2 Three stages in the change process

Planned change should then go through a three-stage process. Lewin called these:

- Unfreeze
- Change (or Movement), and
- Re-freeze.

6.3 Unfreeze

This is the first stage in the change process. It is the process of getting the individuals affected to recognise that change is desirable. Unless they recognise that change is desirable and will improve the situation, they will remain 'frozen' in the belief that the current state of affairs should not be altered.

There are two aspects to 'unfreezing' attitudes.

- Individuals need to be dissatisfied with the current state of affairs.
- They should then be persuaded that the plans for change are attractive, and will provide desirable improvements.

Unfreezing therefore calls for the 'human management' skills of communication and persuasion. Lewin would argue that it sometimes helps to target the individuals who are most opposed to change, and try to win them over to the need for change. If management can persuade the strongest opponents, it should be a much easier task to persuade everyone else.

6.4 Change (or movement)

The second stage in the process is to make the change. This involves moving from the old way of doing things to the new way. Lewin argued that the changes should not be implemented until the 'unfreeze' stage is successfully finished.

Changes should be introduced successfully when management have the full support of the individuals affected.

- Managers responsible for making the change should be given sufficient resources, including money, to do the job properly.
- Implementing the change is more likely to be successful when the individuals affected are allowed to participate closely in the process. Individuals should be encouraged to provide ideas and offer suggestions for dealing with unexpected problems.

Throughout this stage of the change process, it is important to recognise the need for continuing support for the change. Opposition to the change might emerge from individuals or groups affected. The response to opposition should not be to force through the change regardless. Management should try to understand the resistance, discuss the problems with the individuals or groups affected, and find a way of reaching a solution.

For example, resistance to a change may come from employees who are worried about the effect it will have on their working conditions or pay arrangements. A solution may be found by offering improved working conditions, or improved pay and bonus arrangements.

6.5 Re-freeze

Lewin's third and final stage in the planned change process is 're-freeze'. Even if a change is implemented successfully, there is a serious risk that the effects of the change will be lost because the natural tendency of individuals is to go back to old habits and old ways of thinking.

Re-freezing is the process of making sure that the new way of doing things becomes well-established. The attitudes of individuals must be frozen again, but this time frozen into the view that the new system is good and desirable.

Lewin argued that a good way of getting individuals to accept change is to reward them. Rewards might be given through higher pay, bonus incentives or through greater job satisfaction.

Example: British Airways

A well-known example of the ‘unfreeze, change, re-freeze’ model is the privatisation of British Airways many years ago.

British Airways used to be a state-owned public corporation. It was changed into a commercial company with a service-oriented and market-driven culture. The planned changes were extensive, and included a high level of job losses and reducing the number of levels in the management hierarchy.

The change was introduced successfully, by a process similar to Lewin-s three-stage model.

Unfreeze- The organisation recruited a new CEO externally. He had a strong marketing background. A number of task forces were established to look into different aspects of the changes required. There were extensive discussions with staff and their representatives. A high priority was given to training and re-training of staff, especially in the area of customer services.

Change- The changes were implemented, but were reinforced by training programmes about the changes for senior and middle management, and participation by other employees through question-and-answer sessions.

Re-freeze- Individuals supporting the changes were rewarded with promotion. New performance-related pay schemes were introduced. Job satisfaction was also enhanced by introducing new company uniforms and creating a new corporate image with a new logo.

7 MANAGING CHANGE

Section overview

- Strategy for change management
- Requirements for successful change
- Formal planning for change
- Boehm's spiral model
- Using the spiral model approach
- The advantages of the spiral model approach

7.1 Strategy for change management

Introducing a new IS/IT system is often a big change for an organisation, and it can be difficult to manage major changes successfully.

- Making a planned change is about getting from where we are to where we want to be.
- As Lewin suggested, the change process goes through several stages: planning and creating a motivation to change, making the change and then keeping it in place after it has been implemented.
- There are several other requirements for successful change, which are described below.

When implementing a new information system is a major change, it should be planned well in advance, with a formal plan for how the change should be introduced.

7.2 Requirements for successful change

There are several requirements for introducing change successfully. Many of these relate to the skills of management.

- Why is the change needed? There has to be a clear understanding of why the new system is needed, and the benefits that it will provide. All the people involved: need to know
  - need to know the purpose of the new system
  - have a good idea of what the desired end-result will be.
- What changes are needed? There must also be an understanding of what will need to change and what will not change. The organisational and social aspects of change should be recognised, as well as the operational changes.
- There should be a formal plan for making these changes.
- Planning the change process ought to involve the people affected. User participation in the change planning and the implementation of changes will improve the chances of success. Where possible, the users of the new system should be encouraged to 'take ownership' of the system and commit themselves to the changes. Acceptance of a new system, as Lewin suggested, can be reinforced by reward systems.

- Good management. Successful change calls for skilled management and leadership.
- Senior management must demonstrate **commitment**. This is shown by an attitude such as: ‘We’ll keep trying until we get it right’.
- There must also be effective **communication**, between management, system developers and the system users.
- There should be **co-ordination** of the efforts and activities of everyone involved in the project development and implementation. Formal planning is an aid to co-ordination. The new system should also be properly integrated with existing systems.

7.3 Formal planning for change

A major new IS/IT system cannot be introduced successfully without careful planning. However, plans should be flexible, and adapted as circumstances dictate.

- The costs of system development (and implementation and operation) can be controlled through processes such as budgeting and budgetary control.
- There should be a timetable for the project development, including a timetable for training, testing and implementation. The progress of a project towards completion and implementation can be monitored by formal planning techniques such as critical path analysis (CPA).
- There should be a plan for the implementation process itself, so as to keep the disruption under control. One aspect of planning the implementation process is to decide:
  - whether the new system will be introduced in full to replace the ‘old system’ immediately, or
  - whether the system should be introduced in a ‘piecemeal’ way, one part at a time, or
  - whether there should be parallel running of the old and new systems side-by-side until the new system is well-established
  - whether the new system should be ‘pilot tested’ in one area or region first before it is introduced to the rest of the organisation.
- A major risk is the risk that the new system will fail to meet user requirements and expectations. One way of managing change in a way that reduces this risk is the so-called ‘**spiral model**’ approach.

7.4 Boehm’s spiral model

Boehm’s spiral model (1988) was developed as a way of designing and implementing a new IS/IT system. A feature of the spiral model is that the new system is introduced as a series of prototypes. Each successive prototype should make the system conform more closely to user requirements, and (through user participation in the testing of prototypes and suggesting improvements) reduce user resistance.

Features of the spiral model

The spiral model was conceived as a method of systems development that minimises the risk of developing a new IS/IT system that does not meet user requirements, and so becomes an expensive failure.

It minimises the risk because the approach:

- keeps the user involved throughout the development process
- allows the user to evaluate the system at several stages in the development, and to alter the system requirements at each stage.

Its key characteristic is **flexibility. It can be adapted as the user recognises different priorities and different requirements**.

It is therefore a suitable approach for the development of new IS/IT systems that will introduce **substantial changes** into the user's way of operating.

A working system is developed in stages. At each stage, a new version of the system is implemented. The user becomes more familiar with the system with each successive working version of the system, and an understanding builds up at each stage about:

- what the current version of the system allows the user to do
- what the current version of system does not do
- what the user would like the system to do that the current version does not
- what further changes are desirable that should be included in the next working version of the system.

A further advantage of the spiral model is that successive working versions of the system are tested, and design faults and weaknesses should become apparent at an early stage.

7.5 Using the spiral model approach

The spiral model approach uses incremental development for a new IS/IT system.

The user is asked to specify requirements for the new system, and to prioritise these requirements.

A version of the new system is designed to incorporate the main user requirements. The first version of the system is designed, programmed, tested and implemented.

The user gains experience from the first version of the working model to discover whether the system works reasonably well. Any weaknesses in the system can be identified. The user can also find out, from working with the current version of the system, whether there are additional features that should be included in the system to make it better.

A second version of the system is produced, to include the most important changes that have been identified. This second version is then implemented, and the user is able to use the experience from this new version to identify more changes and improvements.

A third version of the system is then produced. This process repeats itself, with as many versions of the new system produced as necessary, until the user's requirements are fully satisfied.

By developing a new system in this way:

- the project is delivered in a large number of small phases
- the new system is evaluated and gradually incorporated into the user's operating environment.

The activities repeated at each stage in the spiral

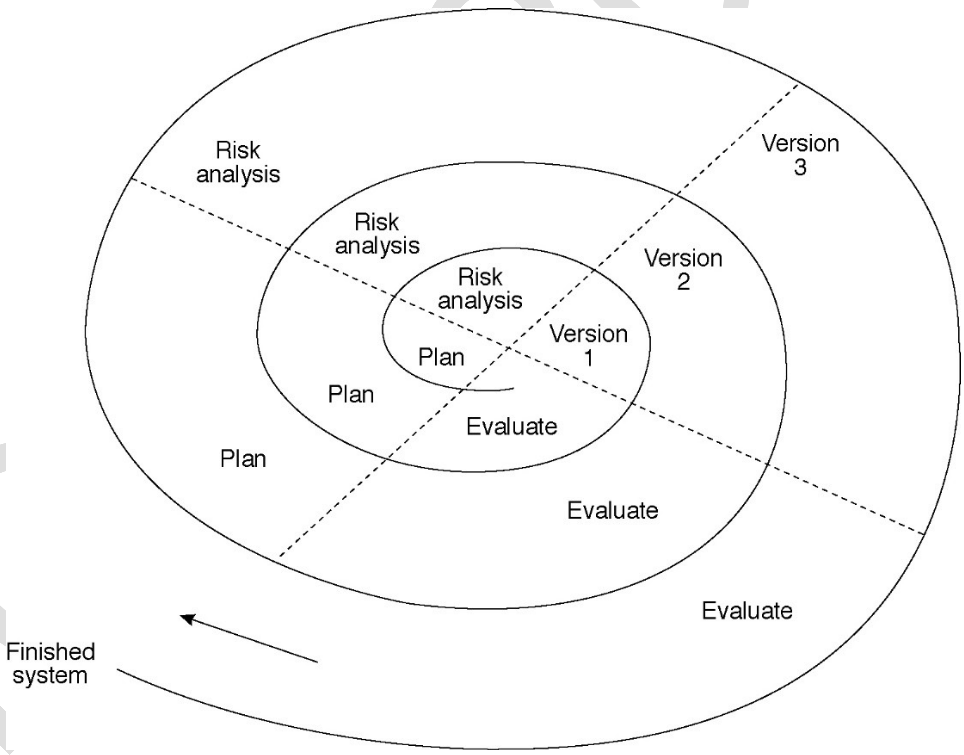
There are four activities at each repeated stage of the spiral model:

- **planning** – deciding the requirements for the next version of the model. Planning for the next version is based on priorities: which new function is most required by the user, or which existing function of the system needs changing and improving the most
- **risk analysis** – identifying what might go wrong with the new version, and working out how to minimise the risk
- **engineering –** designing, implementing and testing the new version
- **customer evaluation –** giving the user the opportunity to evaluate the new version and identify further changes and improvements.

The incremental approach can be shown in a diagram as a spiral, working out from version 1 at the centre, with an additional loop in the spiral for each successive version of the system.

A simplified version of a spiral model diagram is shown below.

General concept of the spiral model



7.6 The advantages of the spiral model approach

The spiral model approach to systems design has several advantages.

- It is highly flexible. It allows the user to make changes to requirements as the systems development progresses. It is therefore well-suited to system development when the new system will introduce substantial changes.
- Because a working version of the system is produced before the final version is reached, the new system can be introduced quickly.
- The user is closely involved in the development, evaluates each working version and identifies new requirements at each stage.
- The risk that the system will be a failure is significantly reduced because:
  - the user gains experience and familiarity with a working version of the system at an early stage
  - for each successive version of the system, there is a formal risk analysis process: the possible risks are identified, and efforts are made to minimise the risks that something will go wrong.

8 EXAMPLES OF MANAGING CHANGE

Section overview

- Company takeovers and mergers: the consequences for IS/IT systems
- Legacy information systems
- Legacy systems: the strategic problem

8.1 Company takeovers and mergers: the consequences for IS/IT systems

When two companies in the same business merge, or when one company takes over another, a strategic decision has to be taken about IS/IT systems.

In the short term, it may be necessary to continue with two different systems, but in the longer term this is not an acceptable strategy. Operating with different IS/IT systems will be inefficient, and it will be difficult to align IS strategy with business strategy for two different sets of IS systems.

A decision will therefore have to be made between:

- Transferring the systems of one of the companies to the systems of the other company, or
- Designing new IS/IT systems for the enlarged company.

Technological issues

The biggest problems with integrating the IS/IT systems of two different companies are usually technical.

- Almost certainly, the two companies will have different IS/IT systems that are not compatible. The systems of one company will not be able to 'talk' top the systems of the other.
- The computer networks of the two companies may be structured differently. For example, one company may have a centralised network with a central minicomputer and database; whereas the other company may have a distributed network of servers.
- Both companies may have databases, but the data on each may be

structured in a very different way. For example, one company may have a hierarchical database and the other may have a relational database.

- One company may have a large IT department with full-time IT staff, whereas the other company may work with only a small IT team and outsource most of its IT work.

Sociological issues

Although technical issues are usually the biggest hurdle to the integration of IS/IT systems after a merger or takeover, sociological or 'human' issues may also be significant.

- After a merger or takeover, there may be an excess of IS/IT staff, and staff will be worried about their jobs.
- This concern about jobs may lead to a bad working relationship between IT managers from the different companies – there cannot be two 'bosses', so which one will lose his job?
- It is often difficult to get employees to accept major changes. A merger or large takeover usually leads to major changes for an organisation. There will often be a re-organisation of work and responsibilities. In some cases, employees may have to be re-trained in new skills.

8.2 Legacy information systems

Definition of legacy systems

Legacy information systems (or legacy IT systems) are IT systems that are an inheritance from the past. They have been defined in several ways, often in a negative way. Here are several definitions.

A legacy system is:

- 'A computer system or application program which continues to be used because of the prohibitive cost of replacing or re-designing it and despite its poor competitiveness and compatibility with modern equivalents.' (Howe)
- 'any information system that significantly resists modification and evolution to meet new and constantly-changing business requirements.' (Brodie and Stonebraker)
- 'Large software systems that we don't know how to cope with but are vital to an organisation.' (Bennett).

Features of legacy systems

Significant features of legacy systems are that:

- They are long-established systems that might have been introduced into an organisation as long ago as the 1970s or 1980s.
- The technology used by the system has been overtaken by newer technology, or by new business objectives and strategies. If the legacy system uses a database, this is likely to be a hierarchical database, rather than a relational database.
- They have been modified since their introduction, but there is now a limit to the amount of further modification that could be made.
- Because they have been in use for so long, they are very reliable.
- They are strategically very important. Many of them support 'mission-critical' operations. Replacing them could therefore be very risky, because the change-over could go wrong.
- Replacing them would also be very expensive.
- Because they are old systems, they do not provide much, or any, competitive advantage.

Many legacy systems developed in the 1970s and 1980s were written in old computer languages such as COBOL\and FORTRAN. They were originally designed for use with hardware such as magnetic tape drives and magnetic disc drives, and for computers with fairly limited internal storage capacity. The systems have been 'modernised' since their introduction, but there are limits to how much more change and adaptation is possible.

There are other features of legacy systems.

- Because they are reliable systems, legacy systems could be more reliable than any new system that is introduced to replace them.
- They might contain large amounts of vitally important business data
- Because they have been used for such a long time, employees are very familiar with them and know how they operate in excellent detail. Legacy systems therefore operate efficiently.
- The systems have been amended and altered so much since they were first developed that there is no proper documentation of the system design and about how the system functions. Since there is little or no system documentation, IT staff have to interpret the coding of the old programs in order to understand what they do and how they function.

8.3 Legacy systems: the strategic problem

The cost of legacy systems

Legacy systems are very expensive to operate. A large part of the problem is that whenever the system has to be updated, the cost of the update is very high.

IT staff do not have any reliable documentation to help them, and the only way they can understand how the system operates is often to read the old program coding. This is time-consuming (and so expensive) and prone to error.

Brodie and Stonebraker (1995) claimed that the maintenance of a legacy system could use up as much as 80% of an entire IT budget. If so, this leaves very little money in the budget for spending on new IT developments.

On the other hand, replacing a legacy system with a new IT system could be extremely expensive. In addition, there would be a risk of loss or corruption to the vital business data on the system.

Whether – and when – to replace legacy systems

The key strategic problem with legacy systems is therefore:

- Whether to replace it – at **high risk** and **high cost**, or
- Whether to continue to use it – with high operating costs and no competitive advantage from the system.

An additional problem is that whenever a new IT system is introduced, it will be modified and amended over time to meet new demands and requirements of users, but will not be replaced. In time, these new IT systems will become legacy systems themselves.

The problem of deciding when and whether to replace a legacy system does not go away until the system is eventually replaced.

Eventually, the high cost of legacy system maintenance and the need to remain competitive will eventually lead to the replacement of a legacy system. When a legacy system is replaced:

- A key decision is to decide **when** to replace it
- The cost of replacing it will be high
- The replacement system will probably have to integrate efficiently with other IS/IT systems

- There will also be a requirement to improve the functionality of existing systems, which means that it will probably be impossible to write a complex system to replace a legacy system on a 1-for-1 basis.

Legacy systems and acquisitions

When a company grows by mergers and acquisitions, it will often acquire other companies with their own legacy systems. A group of companies may therefore,

consist of several companies in the same industry, each with their own legacy systems that are incompatible with each other, and incapable of 'talking' to each other.

There is a very high cost and risk involved in introducing a new IT system for several companies in a group, each with its own different legacy system and slightly different user needs.

9 PROJECT MONITORING AND CONTROL

Section overview

- Introduction
- Quality, time and cost
- Monitoring completion times: slippage
- Amending a CPA chart
- Project management software
- Managing the team
- Role of the accountant

9.1 Introduction

The project manager has the primary responsibility for monitoring and control of projects during their development stage. However, the project manager is accountable to the project steering committee, or the project sponsor or the system user (the customer).

The project steering committee might appoint a **Project Assurance team**, to carry out an independent monitoring role. This team would discuss progress at regular intervals with the project manager. It should also satisfy itself that each milestone for the project has been successfully reached.

9.2 Quality, time and cost

The main aspects of a project that should be monitored and controlled are quality, completion times and cost.

- The quality of the work carried out for the project development can be monitored by comparing actual achievements against the requirements that are set out in the project quality plan.
- The completion time for the project can be monitored by comparing the planned completion times for the critical path activities with the actual completion times.
- Costs can be monitored by comparing actual expenditure with budgeted expenditure, on a regular basis (for example, in monthly budgetary control reports).

9.3 Monitoring completion times: slippage

A CPA chart can be used by the project manager to:

- ❑ Check whether the time-critical activities are being completed on schedule
- ❑ Recognise by how much non-critical activities can be delayed without risking the completion time for the project as a whole
- ❑ Recognise when the completion time for an activity has over-run the schedule (and there is 'slippage' in the timetable for completion) and analyse what the consequences of the slippage will be for the completion time for the entire project
- ❑ Allocate extra resources to time-critical activities if there is a risk of delay, or if the expected slippage is unacceptable.

9.4 Amending a CPA chart

A CPA chart is a management tool to assist project managers with the control over the project completion time. If the chart gets out of date, because critical dates are missed, or because new estimates are prepared for the expected time to complete individual activities, the CPA chart can be updated and re-drawn.

It is important to remember that the CPA chart should have practical value. If it ceases to provide realistic information, it is no longer of any value to a project manager.

9.5 Project management software

Project managers may use off-the-shelf project management software to help them to plan, monitor and control a project. The software enables project managers to use project management techniques with the assistance of a PC or laptop computer.

> **Example: Project management software**
>
> An example of project management software is Microsoft Project.

Features of project management software

Typically, project management software helps project managers to:

- ❑ Create a list of tasks for the project and their expected duration
- ❑ Construct a CPA chart or a Gantt chart
- ❑ Assign resources to each task
- ❑ Prepare a budget for the project
- ❑ Track the progress of tasks (and update the CPA chart from time to time)
- ❑ Record and monitor actual costs
- ❑ Manage the documents for the project
- ❑ Prepare progress reports

Software helps the project managers to amend plans more quickly, and prepare revised CPA charts and Gantt charts, and revised budgets.

It also helps managers to prepare better and more comprehensive project documentation.

The main functions/benefits of project management software

The main functions of project management software can be summarised as follows:

- To produce and edit CPA charts or Gantt charts easily. The project manager simply has to enter the activities, their interdependencies and their expected duration. The software will then construct the CPA chart or Gantt chart automatically. Charts can also be amended when project activities are changed. They can also be updated to the current position at any time during the project, for example when there has been slippage, so that the project manager can establish the current expected completion time for the project.

- To provide an accounting function for the project, by helping the project manager to prepare a budget, record actual expenditure and monitor actual costs against the budget.
- To plan and monitor the use of resources on the project, particularly the number of staff working on the project. The project manager can enter the staff requirements for each activity, and the software will produce a detailed estimate of staff numbers required each day or week of the project. Where the resources required exceeds the resources available, the project manager can then use the software to look for ways of reducing staff requirements at peak times without affecting the overall project completion time, by
  - delaying the start of non-critical activities, or
  - reducing the number of staff assigned to non-critical activities and allowing these activities to take a longer time to complete.

9.6 Managing the team

As well as the technical team management responsibilities described above the team manager is also responsible for managing the team members. Responsibilities may include some or all of the below:

- Selecting personnel and building the team;
- Delegating roles and responsibilities;
- Motivating team members;
- Communicating information amongst the team;
- Rewarding the team;
- Disciplining team members.

9.7 Role of the accountant

The numeracy and business skills of accountants are highly valued in project management. Project managers need to:

- Understand the economics of different options and decisions:
- Be able to forecast costs and profit;
- Generate accurate network analyses and Gantt charts;
- Use spreadsheets effectively;
- Consider the impact of external factors as well as internal factors relevant to the project.

Accountants bring a wealth of business experience to projects and can be highly effective as either project managers or as advisors to project managers.

10 CHAPTER REVIEW

Chapter review

Before moving on to the next chapter, check that you can:

- Describe the impact of IT on employer/employee relations
- Discuss the general problems associated with implementing new systems
- Understand what drives the success or failure of information systems
- Explain the nature of common user resistance to new information systems and change
- Describe Lewin's 'Three Stage' change process
- Discuss tactics for managing successful change
- State key project monitoring and control tasks
- Briefly explain the role of the project manager in managing the team
- Briefly explain the role of the accountant in projects

Skills level
Performance management

CHAPTER

31

Application of information technology in performance

Contents

31.0 Application of information technology in performance management

Introduction

The rapid changes occasioned by technology disruptions have made it necessary to incorporate new elements of technology into various subjects of the professional examinations syllabus, including performance management. This need is supported by the World Economic Forum (WEF) report on the future of jobs 2020, which indicates that Information Technology (IT) skills will be essential requirements for accountants from the year 2021.

The Institute of Chartered Accountants of Nigeria (ICAN), being a member of the International Federation of Accountants (IFAC), has subscribed to the Federation's policy of producing future ready accountants. To this end, skills that will ensure that newly qualified professional accountants are equipped with skills that will make them able to take responsibility in the new global economy.

The IT element in this subject is to provide students with the necessary tools that will be applied in decision making process required in performance management. Therefore, it includes application of technology to decision making and principles of project planning and management.

31.1 Implementing performance management systems

31.1.1 Accessibility

A key factor in the design of a performance management system is the way in which information is to be made available and accessible to the intended users.

Individuals with performance management responsibilities must have information to do their work. IT systems make it possible, in principle, to provide individuals with enormous amounts of data and information. There could be a risk that an information system makes so much information available to users that there is 'information overload'. Individuals may receive so much information that they do not necessarily know what are the most important and relevant items, and so they do not make the best use of the information they are given.

Performance management systems should be designed in a way that makes information accessible in a convenient and helpful way. Users should have ready access to the information they use the most often. They may in addition need access to other information occasionally.

Important factors to consider in the design of a performance management system are:

- What information is needed by individuals using the system?
- Why is the information needed or useful? What will the user do with it?
- How often is it needed?
- Where will the information be obtained from? In other words, how should the source data be captured?
- How should the information user be able to access the information?

For essential and important items of information, it should be the responsibility of the system designers to make sure that individuals are provided with the information.

- Information or data that is essential to carrying out a task must be provided to the user in a convenient way. For example, individuals who use an IT system for operational variance control must be able to access the data they need to drill down into individual variances. Gaining access to this information should be made as easy and convenient as possible for the user.
- Similarly, information that individuals will use often should also be made easily accessible.

When the information requirements of individuals are less predictable, or less frequent, a system might make the information accessible to users, but the leave the responsibility with the user for finding it when it is needed.

For example, intranets have made it possible to provide enormous amounts of data to employees within an organisation. However, there is so much information available that it might become the responsibility of the recipient to make sure that he gets the information that he wants, rather than the responsibility of the provider of information to make sure that it reaches individuals who might need it.

31.1.2 Supporting the tasks of the manager

According to 'traditional' theory of organisation and management, the tasks of management are to:

- Set targets and make plans for achieving those targets;
- Communicate;
- Organise activities;
- Co-ordinate activities;
- Provide leadership or direction;
- Motivate others;
- Monitor performance; and
- Take control measures to improve performance.

Performance management

The new IS/IT performance management systems will be used by managers to manage the performance of the organisation, and individuals and work units within it.

The requirements for the new performance management system include:

- Clear objectives, expressed perhaps as critical success factors;
- Targets for each objective, expressed perhaps as key performance indicators;
- Using these key performance measures to measure actual performance; and
- Providing managers with a comparison of actual performance with the target, or a comparison of target performance with current forecasts.

  IS/IT systems can be designed to provide managers with the key performance measures that they should monitor. For example, executive information systems can be designed so as to provide senior managers with:

- Readily-available information about current performance or historical performance in selected key areas; and
- A facility to 'drill down' to analyse aspects of performance in more detail, if required.

Quality of planning and control

The information provided by the performance management system can improve the quality of planning and control. For example, decision support systems can be used for forecasting and preparing plans. Sensitivity analysis and scenario testing are made much easier with computer models, and these improve planning by testing the assumptions that have been used in preparing the plans and testing the robustness of the plans.

However, there is some risk that performance management systems can be used to plan in excessive detail, or to apply excessive control. Management may use performance management systems to demand regular and detailed reports from employees, to the point where employees spend too much time on reporting and too little time on value-adding activities.

31.2 Impact of IT on employer/employee relations

31.2.1 IT systems and organisation structure

IT-based performance management systems can affect the relationship between employees and management, and between employees and the organisation they work for.

IT-based performance management systems make information more easily accessible. As a result of improved communications and more convenient methods of communication, it is often possible for managers to organise and control the activities of a larger number of subordinates. In other words' the 'span of control' within an organisation may become much wider.

Communication systems, particularly e-mail, allow any individual to contact anyone else. It is possible for a junior employee to send an e-mail direct to the CEO, without the message having to pass through a number of intermediate managers.

In some organisations, there has been some reduction in management hierarchies. Organisations can operate efficiently with a 'flatter' structure (fewer levels of management).

- Although a function of management is to provide information and communication, a large part of this activity can be 'automated'.
- Since employees are able to access information themselves, for example from an intranet database, it is often possible to delegate more responsibility to operating staff, thereby reducing the need for junior management or supervisory staff.

31.2.2 The effect of home working on an organisation

IT has made it much easier for individuals to work from home. For an organisation, the benefits of home-working include:

- A reduction in the need for office accommodation, and so a saving in costs;

- Providing more attractive working conditions for individuals who would prefer to work from home instead of commuting into work: for example, home-working may attract individuals wishing to work from home because of family commitments; and
- Limited disruption to work in the event of a major transport strike.

There are also disadvantages with home working:

- Management - It may be more difficult to exercise management control over individuals who work in a distant location (from home) rather than in direct contact in an office. For example, it can be difficult to co-ordinate the activities of several different home-workers;
- Employees are likely to feel more distant and isolated, and might need strong self-motivation to work effectively; and
- When employees work from home, it is very difficult to make them feel a member of a work team.

31.2.3 Implications of groupware for team-building

The same 'social problem' may arise when groupware is used to help individuals to work together as an electronic team. Groupware allows individuals to function as a 'team' without having to be in close physical proximity to each other. For example, groupware may allow team members to 'meet' and 'discuss' problems electronically, when they are geographically far apart. **This affects working relationships**, because teams linked electronically are unlikely to 'bond' as effectively as a team whose members all work in the same office.

31.2.4 E-mail and work practices

E-mail has had a profound effect on the way that individuals work with each other.

E-mail, the Internet and mobile telephone technology have all created a culture in which individuals expect immediate access to information and immediate responses to queries. Communication has become much faster, and in many cases, this means that tasks are accomplished more quickly, and organisations operate more efficiently.

Disadvantages of e-mail

Although e-mail improves communications, and so can improve the efficiency and effectiveness of a business, there are some potential disadvantages that need to be controlled.

- E-mail users may receive large amounts of junk mail ('spam' mail), although this can be reduced by anti-spam software.
- E-mails may expose a user's computer system to viruses.
- There can be a security problem, when information is sent to someone by e-mail without checking whether the person is authorised to receive it.
- Employees may get involved in 'chatting' to other individuals by e-mail, for example by exchanging gossip or jokes. Friendly exchanges of this sort can become time-consuming.
- Many users tend to respond immediately to e-mail messages, when their time would be better spent concentrating on more urgent issues in hand.

Individuals sending e-mails often expect an immediate response, and are (unjustifiably) annoyed if they do not get a quick reply.

- There is a tendency for users to send e-mail messages without properly checking what they are sending. Messages may contain many typing errors and other mistakes, and the sender may forget to attach documents or may attach the wrong documents.

Some of the disadvantages of e-mail are 'technical' problems, but many are linked to employee behaviour – for example, importing viruses, excessive use of e-mail for chatting, inefficient use of time and prioritising of work.

Using e-mail within an organisation therefore has implications for control over e-mail use, and the ways in which this control should be applied. This affects management/employee relationships.

31.2.5 De-skilling of operatives

As a result of IT, some labour skills have been lost, or replaced by other skills. The automation of many operations removes or reduces the need for individuals to acquire specialist skills.

De-skilling has occurred in many aspects of work. For example, many engineering skills have been automated. Computers can be used to check for faults in an item of equipment (for example, a car) instead of relying on the skills of individual engineers.

Computer systems are also used to automate procedures, such as handling telephone calls from customers. Telephone operatives may be required to follow the procedures set out on a computer screen when dealing with a customer query or complaint, instead of using their initiative.

Consequences of de-skilling may be:

- For the employer, a saving in employment costs (because employees do not have to be as highly-skilled) and lower training costs; and
- For the employee, a loss of interest in the work and pride in performance.

31.3 Problem areas: organisational impact analysis

31.3.1 Problem areas when implementing an IS

When an information system is designed, developed and implemented, several problem areas must be managed carefully.

- The new system should contribute to the economic, financial or operational performance of the organisation. However, when a new system is developed, a 'balance' or compromise must often be made between:
  - A system that meets the user's requirements exactly, and the 'quality' of the system design;
  - Keeping costs within acceptable limits; and
  - Implementing the system within an acceptable time scale.

  It is generally impossible to develop and implement a system of the highest quality within a short time scale and for a low cost.
- The new system is likely to have an impact on organisational and social matters, and in doing so, may arouse strong resistance and hostility form the intended users of the system.

Research has shown that organisational and social issues are significant factors causing new information systems to fail. Even when management have shown an awareness of these problems, their actions are often 'too little, too late'.

A new IS system is 'likely to have a significant impact upon an organisation's culture, structure and working practices'.

Since organisational issues can be a major problem area, it would make sense to consider them carefully at an early stage in an IS project, and try to deal with the problems that are identified.

31.3.2 Organisational impact analysis

'Organisational impact analysis' is, as its name suggests, the analysis of the likely impact of a new system on an organisation, including cultural, structural and political issues and the effect on working practices. It should be carried out at an early stage of a system development, and should not be left until it is too late to take suitable measures to deal with problems.

Organisational impact analysis should be carried out together with an analysis of the contribution that the new system will make to the organisation, in terms of economic benefit or the achievement of strategic goals.

The following issues should all be considered at an early stage in the project development, up to the implementation of the new system, as well as in a post-implementation review.

31.3.3 Contribution of the system to the economic and strategic goals of the organisation

- There should be a regular analysis of the projected benefits from a new system, to assess whether the system is still expected to meet the organisation's needs within an acceptable time scale and for an acceptable cost.
- The proposed system should conform to the current IS/IT strategy of the organisation. (If it does not, the project should be abandoned, or IS/It strategy should be reviewed and changed.)
- Resources should be allocated to an IS project, so that priority is given to the most important parts of the project. This can be achieved using the **spiral model** approach to system development, which is explained later.
- Management should be aware of the need to think about **business process re-engineering (BPR)** in conjunction with developing a major new system.
- A new system should be designed to support planned future changes in the organisation, and so may need to be flexible in order to allow for these future changes when they occur. Management should not focus on current requirements and ignore planned changes in the future.

31.3.4 Human-related issues

Human-related issues should be considered.

- Training. Management should assess whether a suitable and sufficient training programme has been planned for all users of the system.
- It may be necessary to consider health and safety aspects of using the new system, or ergonomic factors. For example, there may be risks from a new

system to the eye sight of users (from working at computer screens), or other aspects of their health. There may be a need for specially-designed chairs for computer users, or a need for regular health check-ups.

- The motivation and needs of system users should be considered. There should be an assessment of how the motivation and needs of the system users will be satisfied (if at all) by the implementation of the new system.
- There should be an assessment of the working styles and the IT skills of the individuals who will be the system users, to decide the implications these may have for system design or training needs.
- Job re-design. There should also be an assessment at an early stage in the system design of whether the new system will change the job specifications of individuals and the relative importance of their work.

All these human-related issues could lead to strong resistance to the new system.

31.4 System implementation

Another aspect of organisational impact analysis should be the period of transition from the old system to the new system, when the new system is eventually implemented. Again, this analysis should begin at an early stage in the project development.

- Management should carry out an assessment of how the planned timing of the new system implementation will interact with any other planned changes in the organisation that will be expected at about the same time.
- There should also be an assessment of the likely disruption to the organisation that implementing the new system will cause, and how long this disruption might last.

31.4.1 Organisation structure, culture and power

There should be an assessment of how the new system will have an impact on:

- The structure of the organisation (for example, will the management hierarchy become 'flatter', will there be more centralisation or decentralisation of authority, or will there be job losses or transfers of staff to other work?)
- The culture of the organisation (defined as 'the set of important assumptions, often un-stated, which members of an organisation share in common')
- The balance of power within the organisation. Information (and knowledge) gives power to the individuals who control it. An information system may alter the balance of power. If this can be foreseen, management can anticipate the political implications of introducing the new system.

Organisational impact analysis is needed because it helps management to identify the potential problems that anew system might create, and do something to resolve the problems before it is too late for effective measures.

31.5 Feasibility study

31.5.1 Purpose of a feasibility study

Definition: Feasibility study

A feasibility study is the first stage in a project to develop a new IS/IT system. The purpose of a feasibility study is to assess:

- **Whether a new information system is required; and**
- **What are the different options that exist for a new system.**

The study should also consider the different options and recommend one of these.

A feasibility study is carried out by a feasibility study group, which prepares a feasibility report and submits this, either to the senior IT manager or to a project steering committee.

In the basis of the feasibility study, a decision is then taken whether to initiate the project and develop and implement the IS/IT system.

31.5.2 The steering committee and the feasibility study group

Definition: Steering committee

The project steering committee should be responsible for supervising and controlling the development of a new IS/IT system. The committee should consist of senior managers with IT expertise, financial project management expertise and business knowledge.

Definition: Project sponsor

The project sponsor is the person with overall responsibility for the new system and may be the head of the steering committee. The sponsor should be the 'project champion'. For example, where the new system will be used entirely or mainly by one department, the project sponsor may be the department, represented on the committee by the head of the department.

The steering committee establishes the terms of reference for the feasibility study. These should include:

- A statement of the purpose and objectives of the new system;
- The scope of the feasibility study;
- The budget limits for the project, if these can be decided before the study; and
- The time scale for the study and the report.

31.5.3 Role of business analysts

Before a feasibility study is started, some work may be carried out by business analysts. The role of a business analyst is to identify new business opportunities to exploit, or business problems that need to be resolved. They might suggest a business solution to the opportunity or problem, which may or may not involve the development of a new IS/IT system.

On the basis of the recommendations of a business analyst, an entity may decide to establish a project steering committee and carry out a feasibility study. The business analyst who recommended the new system will probably become a member of the feasibility study group.

31.5.4 The feasibility study group

> **Definition: Feasibility study group**
>
> **The feasibility study group is the team that carries out the feasibility study. Its members should be appointed by the project steering committee. The group should be fairly small, so that it can work efficiently as a team. It should include:**
>
> - ☐ **IT experts;**
> - ☐ **representatives of the department or departments that will use the computer system;**
> - ☐ **one or more individuals with financial expertise (for example, an accountant); and**
> - ☐ **A business analyst (possibly) .**

31.5.5 Stages in a feasibility study

After the formation of the steering committee, the stages in a feasibility study are as follows:

- ❑ Formation of the study group and setting the terms of reference for the study;
- ❑ Planning the study. The time scales for reporting must be agreed, with a target date for the submission of the feasibility report to the project steering committee;
- ❑ A feasibility study budget should be agreed by the steering committee;
- ❑ **Information gathering** - The first activity in the feasibility study should be to gather information about the current system that is used by the organisation that the new system will replace. Problems with the existing system should be identified and analysed. This task involves collecting, recording and analysing information about the existing system;
- ❑ **Identify alternative systems -** Having identified the weaknesses (and strengths) in the current system, the study group should consider alternatives for a new system that will meet the requirements of the system user better than the current system, at an acceptable cost. Each alternative should be considered in some detail, and an outline system design may be prepared for each. (Since preparing an outline design and testing it for feasibility may take some time, the feasibility study group may consider only a limited number of alternative systems – perhaps just two or three;
- ❑ Each alternative for a new system should be evaluated, using tests of:
  - Technical feasibility;
  - Operational feasibility;
  - Social feasibility; and

- Economic feasibility;

- ❑ The economic feasibility test for a new system involves a **cost-benefit analysis**;
- ❑ The project group decides which alternative system it will recommend to the steering committee; and
- ❑ The **feasibility report** is prepared and submitted, with a recommendation about which new IS/IT system, if any, to develop.

31.5.6 Technical, operational, social and economic feasibility

Each alternative new system considered by the feasibility study group should be tested for technical, operational, social and economic feasibility.

(a) Technical feasibility

The purpose of a technical feasibility test is to decide whether the proposed new system is technically feasible – in other words, whether it could work technically and achieve its intended purpose within the intended cost budget.

Technical issues to consider may include whether the new system

- ❑ Will provide response times that are fast enough for operating requirements
- ❑ Can be connected technically to other existing systems ('integrated' with other systems)
- ❑ Will be able to handle the expected volumes of transactions and processing.

In other words: *Can the system perform technically* in the way the user will want and expect?

(b) Operational feasibility

The purpose of an operational feasibility test is to decide whether the new system can be operated by the user's staff and in accordance with the user's practical needs. The main concern with this test is to ensure that the system will be able to handle *all the operational requirements* that the user will expect?

Matters to consider include:

- ❑ Whether the user's existing staff have the necessary skills to operate the system, or whether they could acquire the necessary skills through training;
- ❑ Whether changes might be needed in the user's organisation structure, for example with the creation of new jobs or the elimination of some type of existing job; and
- ❑ Whether it would be necessary to make other operational changes, such as a change in shift working or working hours, so that the system can operate for more hours each day.

Will these operational changes be feasible?

Other operational issues could affect the feasibility of a project. These include:

- ❑ Data conversion. This is the conversion or transfer of data from the files of the 'old' system to the files of the new system. There may be practical difficulties or risks to the data that could make the new system difficult to install successfully.**Data protection legislation**. The system may need to include personal data about individuals on its files, in which case it may come within the scope of data protection legislation. A check should be made that the proposed new system will comply with **the requirements of the le**gislation.

(c) Social feasibility

A social feasibility test is a test of the likely response of the system's users and customers to the system. For example, if a bank is considering introducing a new system for its account holders (customers) the study group would need to consider what the strength of the resistance might be from customers who may have to use the system.

If a new system would affect the way that employees do their work, or if it would threaten their job security, there could be hostility and resistance to the system that may be difficult to overcome.

If resistance to the new system from users or customers might be strong, the study group may decide that the system is not socially feasible.

(d) Economic feasibility

The purpose of an economic feasibility test is to establish whether the system is economically justified, and whether it can deliver the expected benefits and whether it can be operated within acceptable cost limits.

An economic feasibility test therefore involves a **cost-benefit analysis** exercise, to establish whether the expected benefits from the system would justify the costs of developing and operating it. It is important to identify both the tangible and intangible benefits and costs. The qualitative (intangible) benefits from a new system could be more significant than its quantitative (tangible) benefits.

The feasibility study group is *unlikely to recommend a project unless it passes certain economic or financial tests* of acceptability.

31.6 Cost-benefit analysis: costs and benefits

Definition: Cost-benefit analysis

A cost-benefit analysis involves a comparison of the expected costs of a new system with the benefits the system is expected to provide. The economic feasibility test involves a comparison of tangible costs and tangible benefits. There may also be significant intangible costs or benefits.

Some of the main tangible costs and benefits of a new system are set out in the following table.

Category of cost	Main items of cost
Costs of system development	❑ **Cost of in-house staff** used for system development work. A large number of staff, mainly IT staff and user department staff, will be involved during the development phase for the new project. ❑ **Costs of external IT support**. These costs may include the costs of out-sourced IT development work ❑ **Costs of software purchased** from external software suppliers. ❑ **Costs of new computer hardware** for the new system

Costs of system installation	❑	**Staff training costs**. User department staff will need to be trained in the use of the new system.
	❑	Cost of developing and printing user **instruction guides or manuals**
	❑	**System changeover costs**. Costs will be incurred in converting the data files for the current system and transferring the data to files for the new system.
	❑	There may also be additional running costs if the new system is operated in parallel with the old system for a period of time, until the new system is considered 'safe'.
	❑	**Redundancy costs**. There may be some redundancy costs, if jobs are lost because of the new system.
System operating costs	❑	Costs of **leasing or renting** new equipment or communication links
	❑	Costs of system **maintenance** and updating
	❑	**Outsourcing** costs, for any parts of the new system operations that are outsourced
	❑	Costs of operating a **help desk** for the system.
	❑	Costs of **materials consumed** (e.g. paper for printing) and replacement parts for equipment
	❑	Any **other** additional costs of operating staff

31.6.1 Tangible and intangible benefits

The tangible benefits from a new system should be estimated, if possible, in money terms. In some cases, however, it may be difficult to convert a tangible operational benefit (such as faster response times, or more reliable data) into a money value.

Tangible benefits of a new system may include:

- Higher profits, where the system enables the entity to increase its sales revenue (for example, through the provision of a new e-commerce system);
- Lower operating costs, for example from improvements in efficiency and staff time saved;
- Improved service to customers. For example, an on-line ordering system might result in the faster delivery of purchased items to customers;
- Improvements in accuracy and reliability of data. For example, a new system might provide more up-to-date information for users. Similarly, a new decision support system for managers may improve the quality of information to managers, and help them to make better decisions; and
- Improvements in communications between users of the system.

31.6.2 Cost-benefit analysis: techniques of financial evaluation

The financial evaluation of a proposed new IS/IT system involves a comparison of expected costs and expected benefits. The following list is a reminder of the key relevant techniques you learnt about in other ICAN modules:

- Payback period;
- Return on investment (ROI);
- Discounted cash flow;
- Net present value (NPV); and
- Internal rate of return (IRR).

31.6.3 The feasibility study report

The final stage of a feasibility study is for the study group to produce a feasibility report for submission to the project steering committee. The report should be a recommendation, which may be:

- To develop the system, using one of the system designs studied by the group; and
- To retain the existing system, and not to develop a new system.

The contents of a typical feasibility report are as follows:

- An executive summary, giving a brief summary of the report and its main recommendation(s);
- The terms of reference for the feasibility study;
- The objectives of the new system;
- Information about the feasibility study and how it is carried out;
- An analysis of the current system, its weaknesses and why a new system is required. Also the costs of running the current system;
- The alternative solutions for a new system that the study group considered;
- A recommendation of the preferred alternative solution for the system, supported by tests of feasibility; and
- A plan for the development and implementation of the new system.

If the steering committee accepts the recommendation of the feasibility report, the necessary authorisation for capital expenditure should be obtained. The project to develop the new system should then be initiated.

31.7 Project initiation

31.7.1 Characteristics of a project

Work to develop and install a new IS/IT project is usually organised as a project. A project has number of characteristics:

- The project should have a specific objective. This should be defined in terms of scope (what the system is expected to do), time schedule and cost. In the case of IT development work, a project is to design, develop and install a specific IS/IT system;
- A project team is assembled to carry out the work. Membership of this team may change during the course of the project, as some individuals complete their work and other individuals are brought in to do their part of the work. The management and composition of a project team are considered in more detail later; and
- A project should have a schedule and a time scale for completion. It has a starting time, which is when the project is formally initiated. It also comes to an end, when the IS/IT system has been designed, developed and installed. When the project ends, the project team is disbanded.

An IS/IT project should also have the following characteristics:

- An IS/IT project should have a **sponsor**. The sponsor is the organisation or department financing the project;
- An IS/IT project has a **customer**, who will be the user of the system. The customer may also be the sponsor, but is not necessarily the sponsor; and
- A project requires a **budget** for the design and development work. This should be used to plan future expenditure and also to apply control over actual spending (using a budgetary control reporting system). The cost budget might be divided into a budget for each stage of the development project.

31.7.2 The project management process

The key elements of project management after project initiation are planning and control. However, there are five stages of project management.

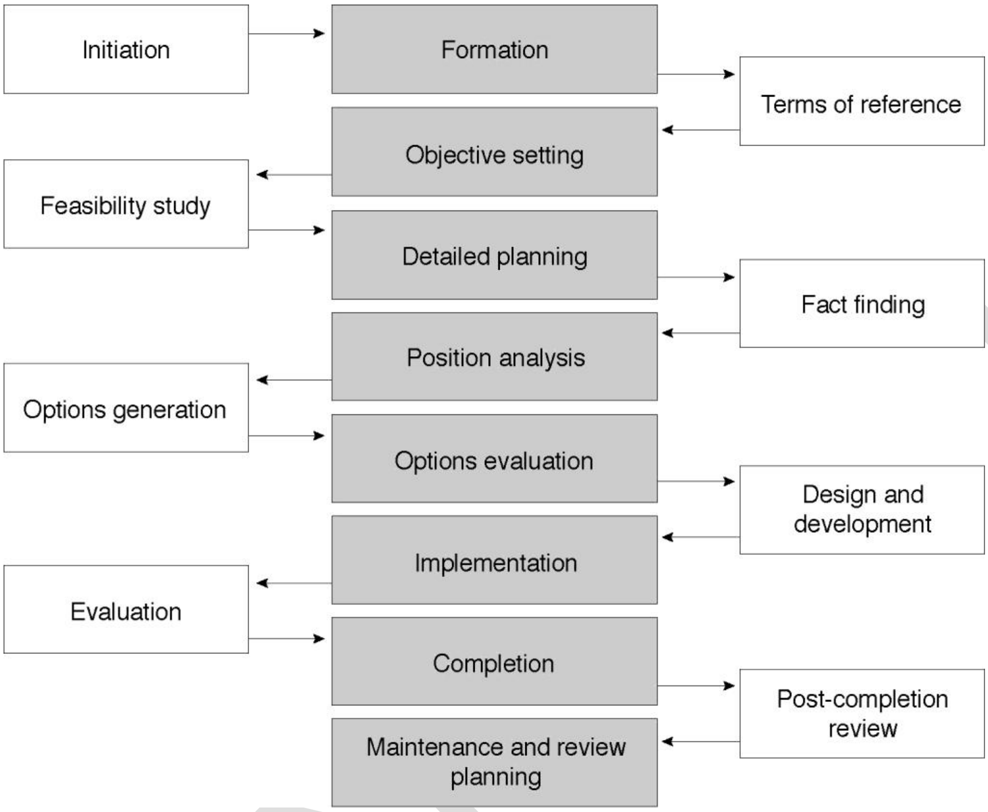
The 5 stages of project management

Stage	Description
1. Initiation	The goals and objectives of the project should be established when the project begins. These can be set out in a **project initiation document (PID)**. The PID is used to develop and clarify the **terms of reference** for the project. The project might be initiated by the Board of Directors, the project sponsor or the steering committee.
2. Planning	The project must be planned. There must be plans for each stage of the project. The plans should specifying the resources required to complete each stage of the project, a schedule (sequence of events and time scale for completion), a detailed budget and performance specifications for the system.

3. Executing	The plans must be put into action. Project management are responsible for directing the project activities.
4. Controlling	The project managers should monitor the progress of the project, to check whether it is on time for completion, within its cost budget and meeting the user's specifications. Where necessary, management should take corrective action when actual performance falls below or behind the plan. Some re-planning and re-scheduling might be required.
5. Completing	The project management must ensure at the end of the project that it has been completed fully and meets requirements. On completion, the responsibility of the project managers ends, and responsibility for running the system is handed over fully to the management for the computer user.

31.7.3 Phases of project development

The stages or phases of project development for a bespoke system are as follows.



31.7.4 Project initiation document and terms of reference

> **Definition: Project initiation document (PID)**
>
> **A project initiation document (PID) is a document that formally establishes the IT project, and provides the authority for the project work to begin.**

There are no widely-accepted 'rules' about what the PID should contain, although it ought to include the terms of reference for the project.

Terms of reference

> **Definition: Terms of reference**
>
> **The terms of reference are a formal statement of what the project is expected to achieve.**

Terms of reference will usually contain the following items:

- A **statement of the business objectives** of the entity, and how the new IS/IT system is intended to contribute to those objectives. In other words, how does the new project fit into the overall plans and objectives of the entity?
- A **statement of the specific objectives of the project** - The terms of reference should state what the new IS/IT system should achieve, and what it is expected to do;

- A statement of the **scope of the project** - The project should have a stated scope. Who is expected to use the project when it is implemented, and who will not use it? For example, will it be specific to a particular department or region, or will it be used by the entire entity? Which operations will be affected by the new project?
- A statement of any **constraints or restrictions** for the project. For example, it might be decided that the project should use in-house IT staff only, and that none of the work should be outsourced; and
- A target **date for completion**.

31.7.5 Other parts of a project initiation document

The PID may also make the following specifications:

- The sponsor and the user (customer) for the project should be identified. The PID should state who has the ultimate authority to approve the project on completion, and who has the authority to resolve any arguments or disagreements that may arise during the course of the project;
- The PID should also specify the resources that will be made available to the project, in terms of staff, technical resources and budgeted expenditure limit;
- The project manager should be identified, and the size and composition of the project team may also be specified;
- There may also be a policy statement on purchasing and procurement, specifying the type of equipment that must be used for the project. (This may be necessary, for example, if the entity has a policy of using compatible IT equipment for all its IT systems.); and
- The PID may also include an outline project plan, although this may not be produced until later (by the project manager, after his or her appointment).

31.7.6 The project manager

> **Definition: Project manager**
>
> **A project manager is appointed to lead the project team. He or she is responsible for achieving the objectives for the project, as specified in the terms of reference.**

Tasks of the project manager

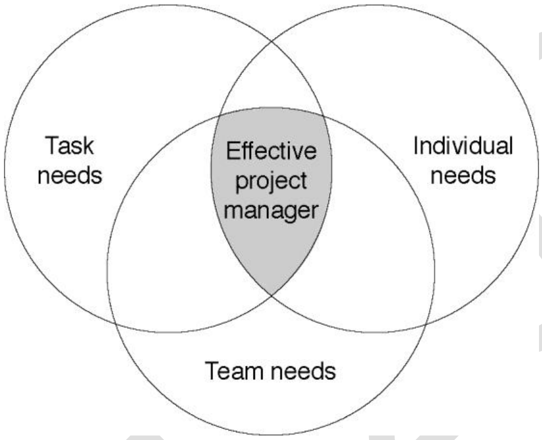
The tasks of the project manager are to:

- Agree the scope of the project (as specified in the terms of reference for the project);
- Produce a project plan, setting out the different stages of the project and times for completion of each stage, and also the resources required during each stage;
- Initiate the work on the project, agreeing individual responsibilities with each member of the project team;
- Liaise with the sponsor and the customer for the project, and discuss the progress of the work and any problems that have arisen;
- Motivate the project team;
- Monitor the progress of the work;

- Ensure that the project meets certain quality standards;
- Report on progress to the project steering committee, project sponsor and customer for the project;
- Deal with any slippage in the work that threatens a delay to completion;
- Ensure that the new system is properly tested and meets its specifications; and
- Deliver the completed IS/IT system at the completion of the project.

The skills of the project manager

According to Adair an effective project manager must satisfy three overlapping needs:



These are (1) the needs to get the task done, (2) the need to create an effective project team and (3) the need to encourage every individual in the team to give commitment to the project. A successful manager gives sufficient attention to all three needs to ensure that the project is completed successfully.

Yeates and Cadle have suggested that a project manager requires the following **core skills**:

- Leadership skills;
- Understanding of technology (IT knowledge);
- Skills in evaluating and decision making;
- People management;
- Communication skills;
- A knowledge of systems design and maintenance requirements;
- Planning skills;
- Control skills;
- Financial awareness;
- Procurement skills;
- Negotiation skills;
- Skills in negotiating contracts; and
- An awareness of legal issues.

31.7.7 The project team

Definition: Project team

The project team must include individuals with the necessary skills and expertise, collectively, to achieve the project objectives and deliver the completed IS/IT system.

A team is assembled for each project, although the composition of the team may change during the course of the project, as the work progresses and new skills are required for the next stages of the work.

For a project to design and develop a new IS/IT system in-house, the project team will include, for at least some of the time:

- **Systems analysts;**
- **Programmers;**
- **Data analysts; and**
- **User department representative(s).**

Systems analysts

Some systems analysts may become involved in a project from the feasibility study stage, as part of the feasibility study group. They have IT expertise, but their specific skills are:

- Analysing existing systems, to establish the user's requirements: they interview staff of the project customer and analyse and document the current system; and
- Developing and designing new systems.

They must provide design specifications for the system that can be approved by the project sponsor, customer or project steering committee. They must also produce a specification for every part of the new system, sufficient to enable programmers to write the software on the basis of the specification provided.

After programming has been completed and the software has been tested, one or more systems analysts should be responsible for systems testing. This involves testing that all the different parts of the software fit together, and that the IS/IT system functions properly as a whole.

Programmers

Programmers write the software for the new system, following the detailed specifications provided by the systems analysts.

Data analysts

Data analysts are specialists in the construction of data files, particularly databases. Their task is to specify, design and build the database (or databases) for the IS/IT system. Most of their work is carried out after the systems analysts have designed the system, although they may assist the systems analysts during the design stage by producing entity-relationship models (described in a later chapter).

User department representative

The user or customer for the new system may appoint a representative to the project team. The role of this representative should be to:

- Ensure that the systems analysts have understood the user's requirements properly, by checking the details of the system design;
- Learn the new system in detail so that the user department has someone with an in-depth knowledge of the system when it eventually 'goes live';
- Organise training in the new system for user department staff, and write the user instruction guide; and
- Organise the testing of the system by the user before the finished IS/IT system is accepted as complete and ready for implementation.

Project team management structure

Project teams usually have a flat management structure. Typically, a project team may have a manager and no other person with seniority over anyone else. Everyone in the team, apart from the manager, is brought into the team to perform a task or function, regardless of his or her experience. There is a distinct absence of 'bosses' and 'juniors'.

This flat management structure is very different from the traditional structure of a large department, such as an IT department, which may have two, three or four grades of management for each IT specialism – for example, chief programmers, senior programmers, programmers and junior programmers.

A flat management structure is ideal for project work, for several reasons.

- A project team is assembled to undertake a specific project and it is disbanded when the project is complete.
- Individuals are brought into a project team to perform a specific task or function, and when they have finished the work for which they were needed, they can leave the project and move to another project.
- The size and composition of a project team therefore varies throughout the project, and this makes it difficult to establish a management hierarchy.
- Individuals are brought into a project team for their skills and the work they can do, not for their management seniority.
- A flat management structure is well-suited to a flexible team structure, and allows an entity to move its staff from one project to another, without having to worry about who is more senior and who should be 'in charge' – other than the project manager.

This flexible structuring of project teams also makes it possible for individuals to move more easily between different projects, and carry out different tasks for different projects. For example, an individual who is the project manager on one project may be moved when the project is completed to another project, as programmer, systems analyst or data analyst.

This flexibility and ability to move individuals from one project to another to do specific tasks, regardless of their 'seniority' or expertise, can only work effectively if salaries are also flexible. Where a flat management structure is used for project work, it is usual to have wide salary bands for each type of employee – for example, a wide salary band for systems analysts. Individuals with a high level of skill and experience can therefore be paid much more than an inexperienced person for similar work.

31.7.8 Project quality plan

It is essential that quality is maintained throughout an IS/IT development project, so that a high-quality system will be achieved at the end of the project.

A project quality plan might be prepared, providing specifications for various aspects of the project, in order to ensure that the required project quality standards are achieved.

The project quality plan may contain the following items:

- **Project overview -** This gives a broad description of the project and its objectives, and identifies the project user/customer. This section of the project quality plan should be consistent with the project initiation document (terms of reference);

- **Project organisation** - This section of the quality plan specifies the management and organisation structure for the project, and the management responsibilities. It includes, for example, the names of:

  - The members of the project steering committee;
  - The project sponsor;
  - The person to contact in each user or customer department;
  - The project manager; and
  - The project team members.

  It should also specify the formal reporting procedures, the methods to be used for monitoring and controlling the project, and the decision-making responsibilities.

  For example, the quality plan may specify that the progress on the project should be monitored by a project assurance team (with named members) which should meet regularly to consider progress reports from the project manager;

- **Project requirements** - This section of the project quality plan specifies the requirements for the project, in terms of what must be delivered. The project work may be divided into phases, with each phase ending when a recognisable 'milestone' is achieved. Target dates will be set for reaching each milestone. (The new project may be introduced in stages.)

  The project specifications should include performance specifications for the new system, security specifications, the required standards and any legal specifications.

  The completed project will be tested against these specifications, to make sure that they have been met successfully;

- **Project development** - This section of the quality plan specifies the methods to be used to develop the new system, and the testing requirements. The different phases of the development work should be identified, with target completion dates for each phase (e.g. detailed system analysis, detailed system design, programming, program testing, system testing, user testing and implementation;

- **Quality assurance** - This section of the plan specifies how the work on the project should be reviewed as it progresses, to ensure that it is being performed to the required standards and specifications. The methods that will be used to carry out quality assurance checks should be specified. Quality assurance can be carried out by means of self-checking, by peer review by colleagues on the project team or by means of external reviews by a review team;

- **Configuration management**. This section of the plan deals with systems and procedures for the control of software throughout the project. There are two main elements to configuration control over software:

  - **Change control** - This is concerned with requests for changes to the detailed specifications for the IS/IT system as the project progresses. When changes are requested, there should be a formal system for documenting the requests – including the reason why the change is needed and why it is desirable. There should be a system for approving requests for changes, and for ensuring that they are made correctly (with suitable changes to all system specifications and programming documentation, and suitable testing to make sure that the change has been made correctly);

  - **Version control**. During system development, programs may be altered many times, to correct errors and to implement approved changes. As a consequence, there may be many different versions of the same program, and only one of them is the 'current' version at any time. A system for labelling each version of every program must therefore be applied, so that there is no confusion about the different versions and the correct version is always used;

- **Testing methods** - The testing methods to be used must be specified. These should include program testing, systems testing and user acceptance testing, to be carried out before the system development is complete;

- **Documentation standards** - A section of the quality plan should specify the documentation that should be produced for the new system. For example, the requirements specification for a project might be drawn up using a standard format in order to ensure that nothing is omitted from the statement of requirements and that the requirements should be comprehensible;

- **Procurement -** A section in the quality plan should specify quality standards for the procurement of hardware and any off-the-shelf software. For example, the quality plan should state that a specified **Invitation to Tender procedure** must be followed for the procurement of major hardware items such as computer equipment and communications link rentals;

- The **work performance of sub-contractors** must also be subject to specified performance quality standards;

- **Risk management** - The project quality plan should also specify requirements for risk management for the project. For example, the plan might specify that there should be a review of risks at each stage of the project (by the project team or project assurance team), and that significant risks should be recorded, together with details of the measures taken to eliminate or mitigate the risks.

31.8 Project planning: phases and tasks

31.8.1 Splitting a project into phases

A task of the project manager is to plan the work for the project, obtain the resources (staff, equipment and so on) to carry out the work and schedule the work so that the project is completed on schedule, or at the earliest possible time.

In order to plan and schedule the work for the project, it is necessary to identify all the tasks that have to be completed.

A first step in the identification of tasks is to identify the main stages of the project. Each stage should have an identifiable beginning and an identifiable end (a 'milestone'). In a typical IS/IT development project the main stages of the project may include the following:

Stage	Starting point	Completion point (milestone)
Project planning	Project initiation document/ terms of reference	Project quality plan
System analysis and design	Project quality plan	Detailed system specification
Programming	Detailed system specification	Completion of system testing
Database design	Detailed system specification	Database design specifications and construction of database
Implementation	Completed system tests and database construction	Handover of system to the user/customer

31.8.2 Breakdown of work into lower-level tasks

When the project has been divided into stages, each with its own identifiable beginning and end (milestone for achievement), the next step is to break down each stage into more detailed tasks, or 'lower level tasks.

For example, the systems analysis and design phase might include, as lower-level tasks:

- Systems analysis and the production of an outline system specification;
- Design of system input;
- Design of system output;
- Design requirements for individual programs (processing requirements); and
- File design.

A large number of lower-level tasks may be identified, although the number of tasks should be restricted. This is because the project manager will need to plan each task, and monitor its progress. Identifying too many tasks could make the job of the project manager too complex.

For each task, the project manager needs to:

- Estimate how much time will be needed to complete the task (measured, perhaps, in man-days or man-months); and
- Allocate each task to specific individuals or small groups.

Work breakdown structure: Prince 2

Definition: Work breakdown structure (WBS)

A work breakdown structure (WBS) is a tool or technique for breaking the total work on a project into smaller and smaller parts, such as:

- the main stages of a project stages
- the lower-level tasks within each stage, and
- work packages, which are items of work within each lower-level task.

Work for each small part of the project can then be allocated to an individual or team. This helps managers to plan the work for the project and allocate each item of work to individual members of the project team.

Example: Prince 2

In the UK, a WBS system in common use for project planning is Prince 2. Prince stands for 'Projects in Controlled Environments'. It was first developed in 1989 by the UK government.

Prince 2 provides 'product breakdown structure' (PBS) for a project development. The project, which is seen as consisting of a number of 'products', is broken down from the top-down into smaller and smaller work packages. This enables the project activities to be identified within the context of work packages. Work packages are allocated to individuals and teams. The project manager can then monitor the completion of each work package to control the project deliverables (including cost, time and quality).

31.8.3 Dependencies between lower-level tasks

A problem with the scheduling of tasks and allocation of tasks to individual project team members is to prepare realistic estimates of how long each task might take to complete. There will be some uncertainty in the estimates.

Another problem is that many tasks in a project are inter-dependent. This means that some tasks cannot be started until other tasks have been completed. For example, program software cannot be written until the system has been specified. Programs cannot be tested until they have been written. A system cannot be implemented by the user until the files in the old system have been converted into files for the new system.

Some tasks can be carried out at the same time, in parallel with each other. For example, programming and database design may happen side-by-side. New equipment for the IT system can be procured whilst the system is being programmed and tested.

In order to schedule a project efficiently, so that it is completed in the shortest time possible (or by a target completion date), the project manager needs to identify the inter-dependencies between certain tasks.

Having specified the tasks to be completed, the resources required for each task, the estimated time to complete each task and the inter-dependencies between them, the project manager can prepare a schedule for the project. It is common to use planning tools or techniques to prepare this schedule. The most common planning tools are:

- **Network analysis** (also called critical path analysis); and
- **Gantt charts**.

31.9 Project monitoring and control

The project manager has the primary responsibility for monitoring and control of projects during their development stage. However, the project manager is accountable to the project steering committee, or the project sponsor or the system user (the customer).

The project steering committee might appoint a **Project Assurance team**, to carry out an independent monitoring role. This team would discuss progress at regular intervals with the project manager. It should also satisfy itself that each milestone for the project has been successfully reached.

31.9.1 Quality, time and cost

The main aspects of a project that should be monitored and controlled are quality, completion times and cost.

- The quality of the work carried out for the project development can be monitored by comparing actual achievements against the requirements that are set out in the project quality plan.
- The completion time for the project can be monitored by comparing the planned completion times for the critical path activities with the actual completion times.
- Costs can be monitored by comparing actual expenditure with budgeted expenditure, on a regular basis (for example, in monthly budgetary control reports).

31.9.2 Monitoring completion times: slippage

A CPA chart can be used by the project manager to:

- Check whether the time-critical activities are being completed on schedule;
- Recognise by how much non-critical activities can be delayed without risking the completion time for the project as a whole;
- Recognise when the completion time for an activity has over-run the schedule (and there is 'slippage' in the timetable for completion) and analyse what the consequences of the slippage will be for the completion time for the entire project; and
- Allocate extra resources to time-critical activities if there is a risk of delay, or if the expected slippage is unacceptable.

31.9.3 Amending a CPA chart

A CPA chart is a management tool to assist project managers with the control over the project completion time. If the chart gets out of date, because critical dates are missed, or because new estimates are prepared for the expected time to complete individual activities, the CPA chart can be updated and re-drawn.

It is important to remember that the CPA chart should have practical value. If it ceases to provide realistic information, it is no longer of any value to a project manager.

31.9.4. Project management software

Project managers may use off-the-shelf project management software to help them to plan, monitor and control a project. The software enables project managers to use project management techniques with the assistance of a PC or laptop computer.

Example: Project management software

An example of project management software is Microsoft Project.

Features of project management software

Typically, project management software helps project managers to:

- Create a list of tasks for the project and their expected duration;

- Construct a CPA chart or a Gantt chart;
- Assign resources to each task;
- Prepare a budget for the project;
- Track the progress of tasks (and update the CPA chart from time to time);
- Record and monitor actual costs;
- Manage the documents for the project; and
- Prepare progress reports.

Software helps the project managers to amend plans more quickly, and prepare revised CPA charts and Gantt charts, and revised budgets.

It also helps managers to prepare better and more comprehensive project documentation.

The main functions/benefits of project management software

The main functions of project management software can be summarised as follows:

- To produce and edit CPA charts or Gantt charts easily. The project manager simply has to enter the activities, their interdependencies and their expected duration. The software will then construct the CPA chart or Gantt chart automatically. Charts can also be amended when project activities are changed. They can also be updated to the current position at any time during the project, for example when there has been slippage, so that the project manager can establish the current expected completion time for the project;
- To provide an accounting function for the project, by helping the project manager to prepare a budget, record actual expenditure and monitor actual costs against the budget; and
- To plan and monitor the use of resources on the project, particularly the number of staff working on the project. The project manager can enter the staff requirements for each activity, and the software will produce a detailed estimate of staff numbers required each day or week of the project. Where the resources required exceeds the resources available, the project manager can then use the software to look for ways of reducing staff requirements at peak times without affecting the overall project completion time, by:
  - delaying the start of non-critical activities; or
  - reducing the number of staff assigned to non-critical activities, and allowing these activities to take a longer time to complete.

31.9.5 Managing the team

As well as the technical team management responsibilities described above the team manager is also responsible for managing the team members. Responsibilities may include some or all of the below:

- Selecting personnel and building the team;
- Delegating roles and responsibilities;
- Motivating team members;
- Communicating information amongst the team;
- Rewarding the team; and
- Disciplining team members.

31.9.6 Role of the accountant

The numeracy and business skills of accountants are highly valued in project management. Project managers need to:

- Understand the economics of different options and decisions:
- Be able to forecast costs and profit;
- Generate accurate network analyses and Gantt charts;
- Use spreadsheets effectively; and
- Consider the impact of external factors as well as internal factors relevant to the project.

Accountants bring a wealth of business experience to projects and can be highly effective as either project managers or as advisors to project managers.

31.10 Chapter review

At the end of this chapter, readers should be able to:

(a) Implement performance management systems;

(b) Explain impact of IT on employer/employee relations;

(c) Identify problem areas: organisational impact analysis;

(d) Discuss system implementation

(e) Explain feasibility study;

(f) Discuss cost-benefit analysis: costs and benefits;

(g) Explain project initiation;

(h) Discuss project planning: phases and tasks; and

(i) Explain project monitoring and control.

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