OPEN UNIVERSITY MALAYSIA

OUM Business School

BBTP3103
Information Technology for Management

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BBTP3103 INFORMATION TECHNOLOGY FOR MANAGEMENT

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COURSE GUIDE

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COURSE GUIDE DESCRIPTION

You must read this *Course Guide* carefully from the beginning to the end. It tells you briefly what the course is about and how you can work your way through the course material. It also suggests the amount of time you are likely to spend in order to complete the course successfully. Please keep on referring to *Course Guide* as you go through the course material as it will help you to clarify important study components or points that you might miss or overlook.

INTRODUCTION

BBTP3103 Information Technology for Management is one of the courses offered by Faculty of Business and Management at Open University Malaysia (OUM). This course is worth 3 credit hours and should be covered over the course of 15 weeks.

COURSE AUDIENCE

This is a core course for students pursuing the degree in Bachelor of Management and Bachelor of Business Administration program.

As an open and distance learner, you should be able to learn independently and optimise the learning modes and environment available to you. Before you begin this course, please confirm the course material, the course requirements and how the course is conducted.

STUDY SCHEDULE

It is a standard OUM practice that learners accumulate 40 study hours for every credit hour. As such, for a three-credit hour course, you are expected to spend 120 study hours. Table 1 gives an estimation of how the 120 study hours could be accumulated.

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Table 1: Estimation of Time Accumulation of Study Hours

STUDY ACTIVITIES	STUDY HOURS
Briefly go through the course content and participate in	3
Study the module	60
Attend 3 to 5 tutorial sessions	10
Online Participation	12
Revision	15
Assignment(s), Test(s) and Examination(s)	20
TOTAL STUDY HOURS ACCUMULATED	**120**

LEARNING OUTCOMES

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

1. Recognise the importance and role of information technology in business;
2. Appraise the information technology infrastructure that can be utilised in the business environment to increase productivity and other requirements of business;
3. Apply information technology as a tool to help solve problems and fulfil the needs of the organisation;
4. Assess the types of information technology that are normally used in business; and
5. Examine the problems, challenges and trends during the implementation of information technology in the business organisation.

COURSE SYNOPSIS

This course is divided into 12 topics. The synopsis for each topic can be listed as follows:

Topic 1 will explains on the importance of information technology to business and discuss the roles and basic component of information technology in the organisation.

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Topic 2 discusses the relationship between business and information technology, which relates how information technology can help business to be highly competitive.

Topic 3 discusses the important aspects of information technology management which consist of component and functions of the computer as well as the use of input and output devices.

Topic 4 discusses the issues of system security, which is to ensure positive effects in the use of information technology as well as suitable security control to avoid exposure to security threats.

Topic 5 discusses on computer hardware and the components in computer systems.

Topic 6 discuses the basic concepts of software, types of software based on several categories and the approach in producing software.

Topic 7 discusses the development of information systems, which is database that stores and manages data.

Topic 8 describes the basic configuration of telecommunications system network and its components, which consist of the hardware, software and individuals that form the support for this network.

Topic 9 explains the types of information systems including functional support systems that play a role in supporting the operational functions within the business and also decision support systems that assist the management to make decisions.

Topic 10 introduces the effects of information systems and information technology on the organisational structure.

Topic 11 discusses the methods of developing a system that covers different stages of the lifecycle of computer software. It will also list several alternative methods in the development of systems which cover the prototyping method. CASE and object oriented system development.

Topic 12 clarifies the issues regarding the management of information technology in an organisation that will result in the fulfilment of organisational expectations. It will also explain the matters which can cause failure of the system in achieving organisational objectives.

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TEXT ARRANGEMENT GUIDE

Before you go through this module, it is important that you note the text arrangement. Understanding the text arrangement should help you to organise your study of this course to be more objective and more effective. Generally, the text arrangement for each topic is as follows:

Learning Outcomes: This section refers to what you should achieve after you have completely gone through a topic. As you go through each topic, you should frequently refer to these learning outcomes. By doing this, you can continuously gauge your progress of digesting the topic.

Self-Check: This component of the module is inserted at strategic locations throughout the module. It is inserted after you have gone through one sub-section or sometimes a few sub-sections. It usually comes in the form of a question that may require you to stop your reading and start thinking. When you come across this component, try to reflect on what you have already gone through. When you attempt to answer the question prompted, you should be able to gauge whether you have understood what you have read (clearly, vaguely or worse you might find out that you had not comprehended or retained the sub-section(s) that you had just gone through). Most of the time, the answers to the questions can be found directly from the module itself.

Activity: Like Self-Check, activities are also placed at various locations or junctures throughout the module. Compared to Self-Check, Activity can appear in various forms such as questions, short case studies or it may even ask you to conduct an observation or research. Activity may also ask your opinion and evaluation on a given scenario. When you come across an Activity, you should try to widen what you have gathered from the module and introduce it to real situations. You should engage yourself in higher order thinking where you might be required to analyse, synthesise and evaluate instead of just having to recall and define.

Summary: You can find this component at the end of each topic. This component helps you to recap the whole topic. By going through the summary, you should be able to gauge your knowledge retention level. Should you find points inside the summary that you do not fully understand, it would be a good idea for you to revisit the details from the module.

Key Terms: This component can be found at the end of each topic. You should go through this component to remind yourself of important terms or jargons used throughout the module. Should you find terms here that you are not able to explain, you should look for the terms from the module.

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References: References is where a list of relevant and useful textbooks, journals, articles, electronic contents or sources can be found. This list can appear in a few locations such as in the Course Guide (at References section), at the end of every topic or at the back of the module. You are encouraged to read and refer to the suggested sources to elicit the additional information needed as well as to enhance your overall understanding of the course.

PRIOR KNOWLEDGE

Learners of this course are required to pass BBPP1103 Principles of Management course.

ASSESSMENT METHOD

Please refer to myINSPIRE.

REFERENCES

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Topic 1 ▶ Business and Information Technology

LEARNING OUTCOMES

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

1. Explain the importance of information technology in an organisation;
2. Differentiate between data, information and knowledge;
3. Assess three characteristics of quality information; and
4. Appraise basic components of information technology.

▶ INTRODUCTION

In this era of information technology, there is a close relationship between business strategy, rules as well as procedures in business and information technology. In this topic, we will investigate the importance of information technology to business and look at the definition of information technology as well as its components.

1.1 IMPORTANCE OF INFORMATION TECHNOLOGY TO BUSINESS



ACTIVITY 1.1

Think about your own life. What are the changes you have experienced that are closely related to the development of information technology? Discuss.

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Can you feel that the world of business today is quite different from that of the past? Many developments, transformations and major changes have occurred. These have had a big impact on the preparation processes that must be undertaken by an individual in order to remain active in the world of business. Many things that we did not need to know back then have now become a necessity. One example is knowledge about information technology.

Look at how the application of information technology like the use of web-based information systems has played a large role in helping the business sector to fulfil its needs. For example, from the perspective of improving the efficiency of processes in business, aiding in the decision-making process and enabling more effective group collaboration. This has directly fortified the position of a company involved in marketing that is ever increasing in size and complexity today.

What new patterns are emerging in the business environment all over the world today? The three major changes are globalisation, industrial economy and enterprise.

1.1.1 Development of Information Technology and Changes in Business

The development of information technology has changed the pattern of relationships among organisations. Today, business involves management and control in the global market. Competition among organisations is not limited by area, state or country but has gone onto the world stage.

It is not only from the perspective of globalisation; industrial economy has also emerged in a new scenario. Knowledge is now recognised as a productive and strategic resource. Society in general is engrossed in the issue of knowledge and information based on economy. Many new products and services for the short term have been introduced.

Other major changes are in the enterprise industry. The many layers within an organisational structure are decreasing. Many traditional positions have been removed while at the same time, new ones are being introduced. A work atmosphere that is more flexible in terms of distance, time and method of communication has become a reality. Overall, transaction and coordination costs have become relatively lower than before.

The changes discussed above have brought about major changes in the way people work, communicate and solve problems while they grab the new opportunities that turn up in their daily lives. Do you agree that information

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technology has emerged in all facets of life and has started to change the work culture as well as shape the business sector into an entity that is vastly different from before?

The following are several examples of organisational websites that carry out their business based on information technology. Observe how the use of information technology increased the profit of the companies involved as well as attracted more customers:

- UPS – United Parcel Service – www.ups.com
- Maybank Group – www.maybank2U.com.my
- Telegift Corporation Sdn. Bhd. – www.telegift.com.my

1.1.2 Role of Information Technology in the Organisation

Information technology plays a major role in ensuring the success of an organisation today. Its role has expanded over time. If during the earlier stages information technology was used only to automate repeated tasks involving large quantities, today we are witnessing a significant shift in its role. The use of information technology has helped from the perspectives of:

- Business process and operations;
- Decision making in business; and
- Strategic competitive advantage.

In this part, we will discuss the role of information technology in the organisation from the following perspectives:

- Widening relationships within the organisation; and
- Introducing a new alternative in organisation design.

(a) Role of a Computer Network in an Organisation

A computer network plays an important role in changing the topology of business. It enables the performance of transactions across great and distributed distances. You must have used this facility in your daily life. For example, you no longer need to go to a particular branch of a bank in order to make a deposit or withdrawal since these transactions can be performed at any branch of the bank connected to the computer banking network.

There are many types of network technology that enable online connections to be performed. The network technology that is firmly in place today comprises the Internet, Intranet and extranet.

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What is the Internet? **Internet** is an international network that consists of a collection of computer networks and millions of personal computers that are connected to it. Basically, the Internet is a global information highway. Anybody can connect to this highway by building an "appropriate road" to join his house to this highway. This "road" from the user's home can be in the form of a telephone line through the use of a modem or a local area network. Figure 1.1 illustrates this.

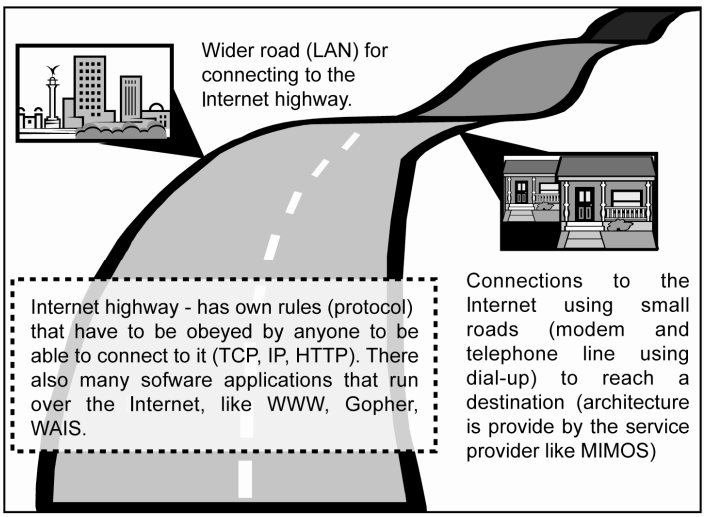


Figure 1.1: Internet highway

The **intranet** is an Internet network that is limited in access for certain organisations only. It is an internal network that uses Internet technologies, which allows employees of an organisation to apply leaves, or submit claims online from their workstation.

The **extranet** is the use of the Internet technology for access from outside an organisation. A portion of a company's network that allows customers or suppliers of a company to access parts of an enterprise's intranet, for example, to check the price list or make orders online.

Internet, intranet and extranet are responsible for the change in the way organisations conduct their business. They have become an important information infrastructure in many organisations. Figure 1.2 illustrates the relationship between Internet, intranet and extranet.

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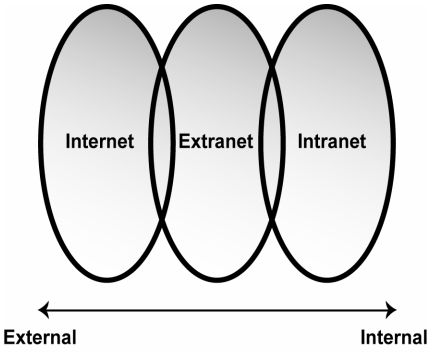


Figure 1.2: Relationship between Internet, extranet and intranet

Further details on the network technology will be covered in Topic 8.

The Internet phenomenon has enabled electronic trading or e-commerce that is increasing in value from year to year. In general, e-commerce is the process of buying and selling goods and services through the Internet while electronic business (e-business) uses the Internet and other digital technology like e-money and e-certificate to enable online sales and purchases. Generally today, global trading is becoming more dependent on the Internet and computer networks.

Traditional business activities like capital sourcing, marketing, and sale and purchase agreements have become part of the common Internet activities of organisations.

(b) **Role of Information Technology in the Organisation – A New Alternative for Organisation Design**

Do you agree that the use of information technology has decreased the levels or layers within the management structure of an organisation? Many new work opportunities are being presented, while at the same time many are being discontinued. The workplace can be separated from the work that needs to be done. In other words, the work can be performed remotely with the use of a computer network.

The work flow within an organisation has also changed. More flexibility has been achieved in many situations, and boundaries within organisations need to be redefined.

The use of information technology could decrease the levels or layers within the organisational structure in terms of inter-departmental communication and transactions of data and information, which "flatten" the levels of the management structure. This will be discussed further in Topic 2.

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ACTIVITY 1.2

In your view, how can an organisation operate without using information technology? Discuss with your friends how information technology has changed the design of an organisation where you are involved as an employee or a student.

SELF-CHECK 1.1

Discuss three major changes that have occurred in the business environment all over the world that are closely related to the development of IT. Include two examples for each change.

1.2 WHAT IS INFORMATION TECHNOLOGY?

Information technology is a technology that can be used to manipulate data and information, which is to process, store, produce and disseminate data and information. In this section, we will discuss the concept of information and clarify what information technology really is.

1.2.1 Data, Information and Knowledge

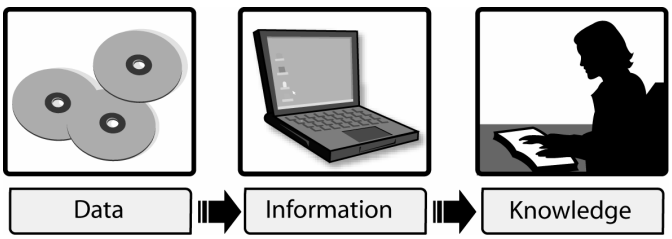


Figure 1.3: Relationship between data, information and knowledge

In the context of information technology, **data** is raw facts stored in a computer for processing. For example, the data may be the names, types, prices and quantities of products. Data has many uses for an organisation after it has been processed by a computer. Using the above examples, if the computer is directed to record all the daily business transactions of that particular organisation, then the organisation will be able to obtain all product names that have been sold on a particular day as well as the quantity and price sold at any centre and so on.

Information is data that has been processed. It can consist of the total, summary, charts and others. It is usually more brief and compact, and it is adapted to the needs of that particular organisation. For example, let us take two types of data, which are the names of students and the courses taken. If we join and process

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both data types, the information that is produced will be more meaningful. We will be able to know the number of students taking a particular course at any given time.

Knowledge consists of information that has been arranged and processed to convey understanding, experience as well as expertise which is to be used in solving current business problems. For example, it could be information that is presented in charts, which gives knowledge about the trend in profit for management. It prevents the managers from making the same mistakes made by others. Refer to Figure 1.3 for a brief relationship between data, information and knowledge.

Overall, data is processed into information, and information is processed into knowledge.



SELF-CHECK 1.2

Explain the relationship between data, information and knowledge, according to the process.

Information is one of the main assets of an organisation today. Every manager needs to use information to perform his tasks, especially to make a decision. Therefore, valuable information becomes the main agenda of every manager. If they are not capable of making use of quality information, the company will lose its ability to compete with other companies.

The use of technology helps make management and access to information more efficient. Nowadays, it is a challenge for an organisation to ascertain its information requirements and direct the use of information systems to fulfil those requirements.

1.2.2 Characteristics of Quality Information

What are the characteristics that can make information valuable to a company? What are the characteristics that can render the information useless and not valuable?

Table 1.1 shows the characteristics of quality and valuable information to an organisation. Information of poor quality will contribute towards inaccurate decision making and this will have a negative effect on cost for the organisation. Therefore, information must have certain characteristics in order to make it an important asset to the organisation.

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Table 1.1: Characteristics of Quality Information

Information Characteristics	Description
Time	• Available when required • The latest information • Can be produced as frequently as required • Able to provide previous, current and future information
Content	• Accurate and free from errors • Verifiable and can be proven as correct or incorrect • Organised and arranged to suit the needs and requirements of a particular user • All required information should be provided • Only information that is required should be made available and accessible • Information scope can be as wide or as narrow as it needs to be and can have internal or external focus • Can show levels achieved by measuring completed activities, performance rate and sources collected • Useful and has meaning to the person who receives the information
Form	• In a form that is easy to understand • Can be obtained in detailed or summarised form • Can be aggregated as required • Presentable in narrative, numerical, graphical and many other forms • Can be displayed on paper, video or other media



SELF-CHECK 1.3

1. In information management, there are three important aspects that should be emphasised to guarantee access to quality information. Discuss these aspects.
2. Explain the reasons that can make information lose its value.

1.2.3 Basic Concept of Information Technology

Information technology was developed through the combination of computer technology and telecommunications technology. It refers to all types of technology that support the storing, processing and disseminating of information.

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1.2.4 Components of Information Technology

Try to recall the definition of information technology. Can you list the components?

In its narrow definition, **information technology** refers to the technological side of an information system, which include hardware, software, database, networks and other components. The basic components of information technology are as shown in Table 1.2.

Table 1.2: Basic Components of Information Technology

Component	Definition	Function	Example
Hardware	A set of devices like a processor, screen, keyboard and printer.	Receives, processes, displays, stores and prints data and information.	Machine category: Computer, display screen, magnetic disk drive, printer and scanner. Media category: Diskette, magnetic tape, optical disc.
Software	A set of computer programs or programming software that covers all sets of instructions for the computer, including programs and procedures.	Enables the hardware to process data.	Operating systems, word processors, electronic spreadsheets.
Database	An organised collection of information consisting of data, files, records and others.	Stores data and information as well as the relationships between them.	Data is entered through a software like Microsoft Access and Lotus 123.
Communication Network	A network system, which connects computers and other electronic devices via telecommunication networks.	Allows the sharing of resources between computers.	Internet, intranet, extranet.
Procedure	Strategies, policies and rules for using information systems.	Ensures the reliability of data.	Procedures for data entry, error correction, check allocation.

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Human	People who work with information systems, whether they are information experts who are responsible for the development and operation of the system, or end users who use the system.	Operates all information systems.	Information experts like system analysts, software developers or system engineers and data administrators. End users like accountants, sales personnel, clerks and customers.

1.2.5 Information System

One of the main applications of information technology in business is the **information system**. The main function of the information system is to store and process information that is needed by an organisation. Table 1.3 shows the trends of information systems and their role in an organisation.

Table 1.3: Trends of Information Systems and their Role in an Organisation

Year	Type of Information System	Scope and Role
1950s	• Electronic Data Processing (EDP)	Used in the operational parts to assist in daily transaction processes
1960s	• Transaction Processing System • Information Management System • Office Automation System (OAS), for example word processing systems, airline reservation systems, computer-aided design and manufacturing (CAD/CAM)	Assisted in routine decision making in the functional areas
1970s	• Decision Support System (DSS)	Supported complex, non-routine decision making in the organisation
1980s	• End User Computing System • Client/Server Executive Information System (EIS) • Executive Support System (ESS) • Group Support System (GSS) • Artificial Intelligence, for example Expert System (ES) and Knowledge Based System • Strategic Information System (SIS)	Strategic and operational support and consultation

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1990s	• Integrated software, for example Enterprise Resource Planning (ERP), Human Resource Management (HRM) • Smart Web Systems, intranet, extranet	Competitive advantage for the organisation to compete in the global market
2000s	• Corporate portals • e-Business and e-Commerce • Customer Relationship Management (CRM) • Business Intelligence and Data Warehouse • Integrated support systems, for example a DSS-ES combination	Competitive advantage for the organisation in terms of knowledge management and "competition over customers"

SUMMARY

- Information technology plays an important role in ensuring that operations and collaborations in today's business and organisational processes continue efficiently and effectively.

- It consists of a group of components that are interconnected and work together towards achieving particular objectives by receiving inputs and producing outputs in an organised change process.

- One of the main applications of information technology in business is the information system. Information systems support:
  (i) Business process and operation
  (ii) Decision making in business
  (iii) Competitive advantage that is strategic

KEY TERMS

Communication network
Database
Hardware
Information technology
Information system
Software

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Topic 2 ▶ Information Technology Support and the Organisation

LEARNING OUTCOMES

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

1. Analyse the relationship between the organisation and information technology;
2. Describe three types of structures in an organisation;
3. Discuss the implementation of information technology in the organisational structure; and
4. Explain the architecture and infrastructure of information technology.

▶ INTRODUCTION

The development of information technology facilities is closely related to the business objectives of an organisation. This is a manifestation from research on the requirements of information towards enhancing organisational results. Therefore, information technology facilities are actually very closely related to the organisational structure and are based on the main functions of the organisation.

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2.1 RELATIONSHIP BETWEEN THE ORGANISATION AND INFORMATION TECHNOLOGY

The organisational business objectives need the proficient use and management of information in order to make it possible for the organisation to function efficiently to achieve maximum production. Today, information has become a necessity that is a factor in deciding the success or failure of an organisation. Information has to be managed well in order to obtain maximum advantage from its use. This proficient management can be achieved through the use of information technology that is increasingly more advanced and complex.

Organisational information needs are manifested in the development of information technology based on the analysis of the information requirements. From one perspective, information technology that is developed has emerged from the information requirements of an organisation in the form of information technology applications. Information technology that is developed is characteristically software in nature that needs a suitable environment for it to function. In order to achieve this, an appropriate information design is needed.

Information architecture is the mapping of the information needs of an organisation that is implemented in the form of information technology as well as how it is to be implemented. It must take into account the direction of the implementation and management of organisational information in the future.

Realisation and implementation of this information technology requires a certain support infrastructure that can support the constructive implementation that involves particular equipment and software. This relationship is illustrated in Figure 2.1.

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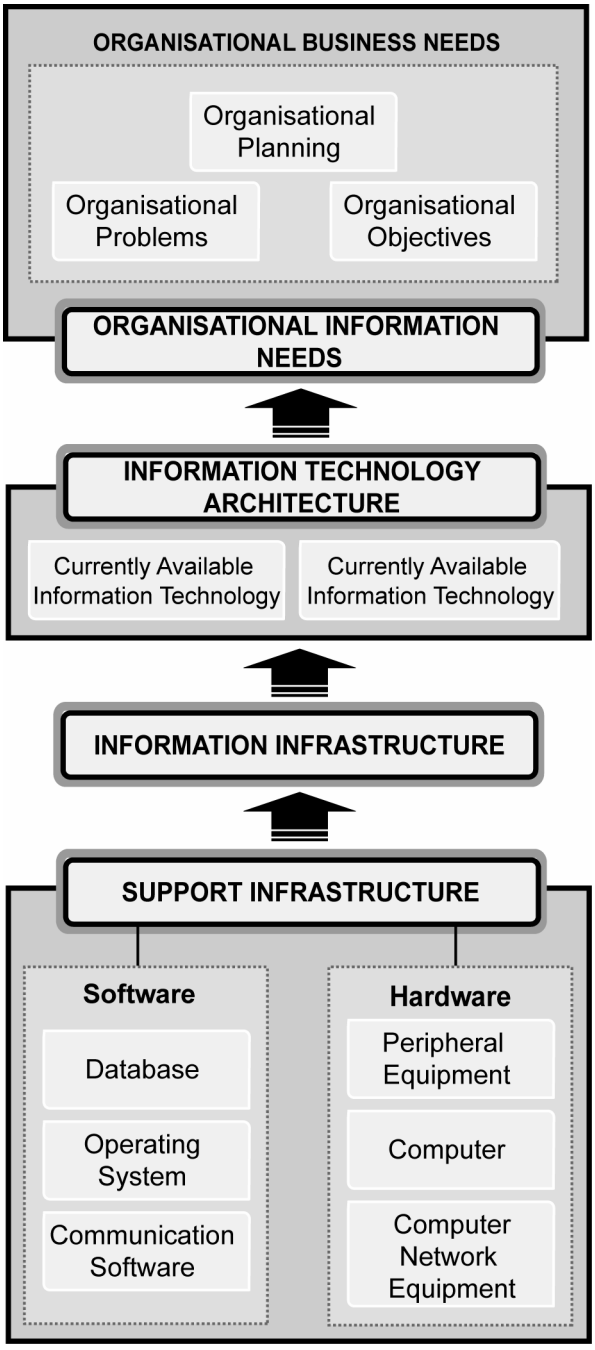


Figure 2.1: Relationship between organisational needs and information technology architecture, and information infrastructure

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Based on Figure 2.1, try and observe, in general, the effects from this relationship on the approach for constructing information architecture and usage of information technology in the organisation. Information technology planning and information technology usage begin from the top. The use of technology must begin with an analysis of the organisational needs in the context of the business the organisation is involved in. It must support the success of organisational business planning and its objectives. Therefore, the process of designing information technology involves the current user or potential users of information technology in the future, as well as the management and planning personnel in the organisation. The development of information technology characteristically described above does not involve technologists alone.

Only at the end of the process of designing information architecture would the technology be chosen to support the operational process.



ACTIVITY 2.1

1. Visit the website for General Electric (www.ge.com) and compare it with the website for Kodak (www.kodak.com). Try to differentiate the organisational objectives of these two websites.
2. Plan an approach for developing an information architecture from the bottom, which is by looking at the current available technology. Then suggest the information technology development that can operate over it. Following this, compare it with the approach discussed previously.

2.2 UNDERSTANDING ORGANISATIONAL STRUCTURE

An organisation is usually structured based on the division into smaller units in order to facilitate the administrative and management functions. This division can be based on location, function and other characteristics. Important factors that influence organisational structure are the size and location. Both these factors rely on the type of business the organisation is involved in, whether in the form of a service offered or the production of goods, and the company's characteristics of being either local or global.

An organisation usually has a single head office that is the location for policy making, strategic planning and company performance analysis. Going down another level, this company may be divided into divisions that may be located in different sites.

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These divisions will then be divided further into units. In an organisation that does not have many branches in many different places, the division may be performed based on function, that is, a division or unit represents a certain function.

A unit that is usually the smallest unit that performs the main functions of the organisation is called a department. Normally, an organisation is divided into the following departments (there could possibly be more departments):

- Accounts;
- Finance;
- Sales and marketing;
- Production and operation management;
- Human resource management; and
- Information systems.

2.2.1 Types of Organisational Structure

There are many types of organisational structure. In general, we can divide these different structures into three forms:

- Traditional or hierarchical
- Project based
- Matrix or multidimensional organisation

Let us look at these structures one by one in greater detail.

(a) **Traditional or Hierarchical Structure**

A hierarchical structure is a basic structure that is most widely used in organisations today. In this structure, the strategic and planning roles are placed at the highest levels, while production and implementation are placed at the lower levels. This structure is illustrated in Figure 2.2. In this hierarchical structure, the organisation is viewed as a structure with the highest level having more power and authority than the level below. The number of levels differs among organisations in accordance with the goals of the organisation. The trend adopted today is to reduce the number to the minimum. This means that more power and authority are passed down to the next level in certain situations. The effect is that more information must be made available to the lower levels so that decisions can be made more effectively in the lower levels of the hierarchy.

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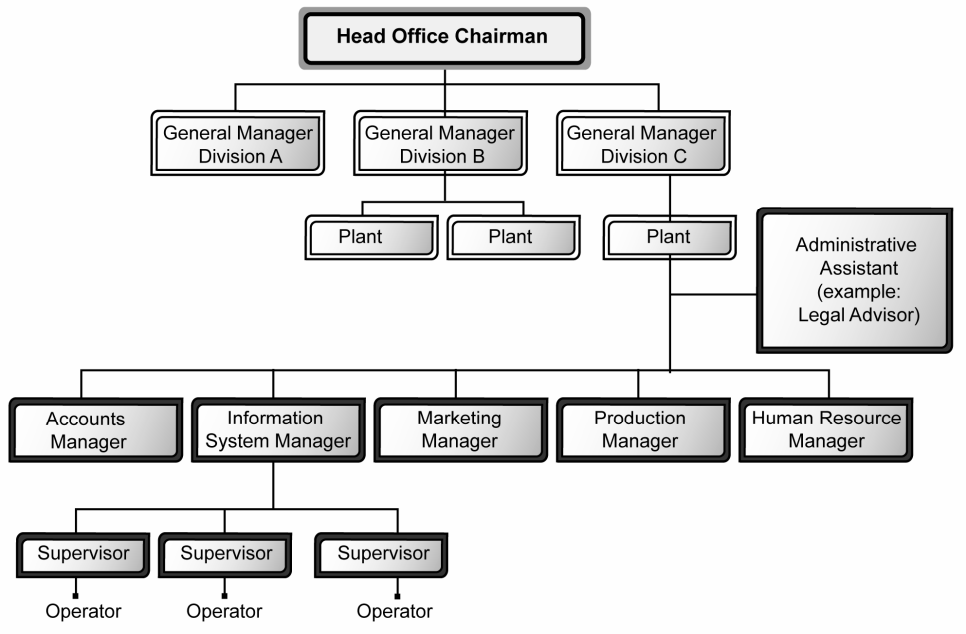


Figure 2.2: Example of a hierarchical organisational structure

(b) **Project-based Structure**

Figure 2.3 gives a general idea of this type of structure. In the hierarchical structure, the division of segments is generally based on the area or zone (division). If this division is made based on the type of main product or service (if the company offers a service), then it is known as a project-based organisational structure. A team that is based on a project can sometimes be characteristically permanent and has ad hoc or temporary features based on the duration of that project. In this structure, the main basic organisational functions such as finance, accounts, marketing and production are normally placed at the bottom of a group or division based on the project.

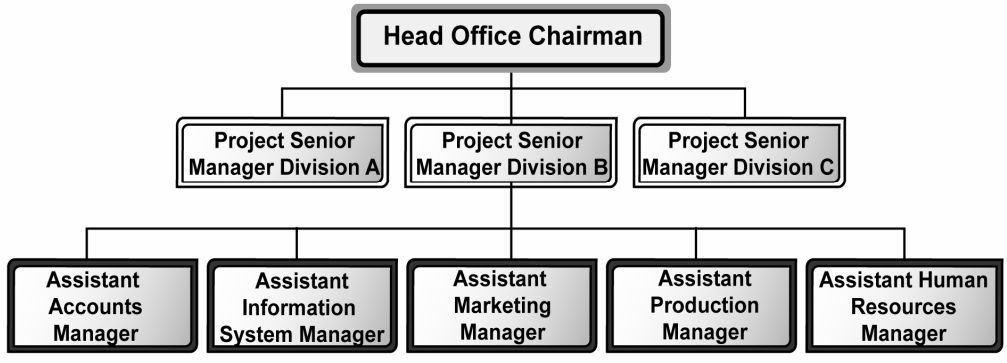


Figure 2.3: Example of a project based organisational structure

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(c) **Matrix or Multidimensional Structure**

In general, a matrix structure is based on a project but with a significant difference, which is, the group members can be from different projects; whereas the project- based structure limits the members of a project to a single grouping. Figure 2.4 shows an example of this structure. The group in this matrix is a permanent group that is directed to manage a series of special projects. A problem that arises in this type of structure is the existence of two command flows from two different superiors. This is because its basic characteristics are from the crossings between different groups.

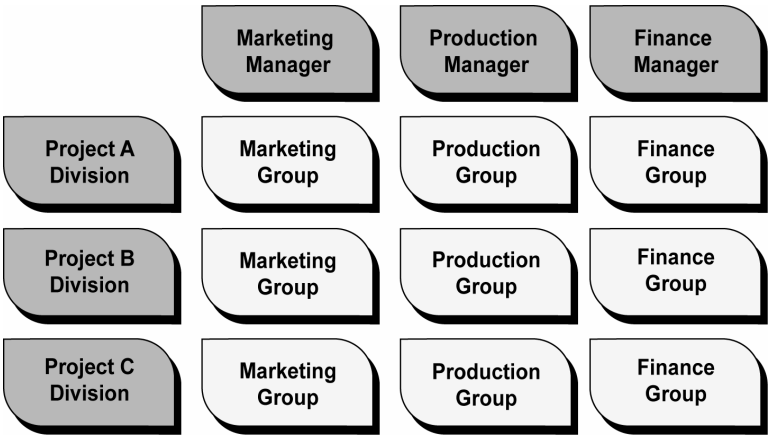


Figure 2.4: Matrix structure – this arrangement forms a matrix figure. Each group is under two superiors (division leader and manager)

SELF-CHECK 2.1

List the types of organisational structure and compare them from the perspective of the most appropriate structure at a given time.

2.3 IMPLEMENTATION OF INFORMATION TECHNOLOGY IN ORGANISATIONAL STRUCTURE

Looking at the forms of organisational structure discussed previously, we can determine the implementation of information technology based on the levels of organisational units. Table 2.1 shows the examples of information technology support that can be given by information systems in each level of the organisation.

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Table 2.1: Levels of Information Systems

Level	Characteristic
Departmental Level	Collaboration of small programs developed by each department to support other departmental functions. This covers the human resource management information system and accounts information system.
Plant Level	Collaboration among departmental information systems. Generally enables a connection among departments to be performed to enable employees to work together using a computer system.
Divisional Level	Collaboration of plant information systems.
Enterprise Level	Collaboration of divisional information systems.
Organisational Level	An information system that is larger and more complex that can provide a connection of information systems among organisations. This system enables the same information to be used among different organisations.

2.4 INFORMATION TECHNOLOGY ARCHITECTURE AND INFRASTRUCTURE

As we have learnt previously, information architecture is a direct mapping of the informational requirements of an organisation. How is this mapping done? In an organisation, information is usually extracted from one user to another after it is processed by the information system from one function to another. How is this distribution of information performed? It requires a form of information architecture that can ensure the information is able to flow from one user to another for the purpose of processing and sharing information. For this purpose, we will discuss three types of information architecture that have become the work environment in an organisation:

(a) Mainframe and terminal environment

(b) Peer-to-peer or PC environment

(c) Distributed environment

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2.4.1 Mainframe and Terminal Environment

In this environment, a large and powerful mainframe computer is connected to several terminals that become an interface to the user. Figure 2.5 illustrates a simple centralised environment that is connected to a single mainframe computer.

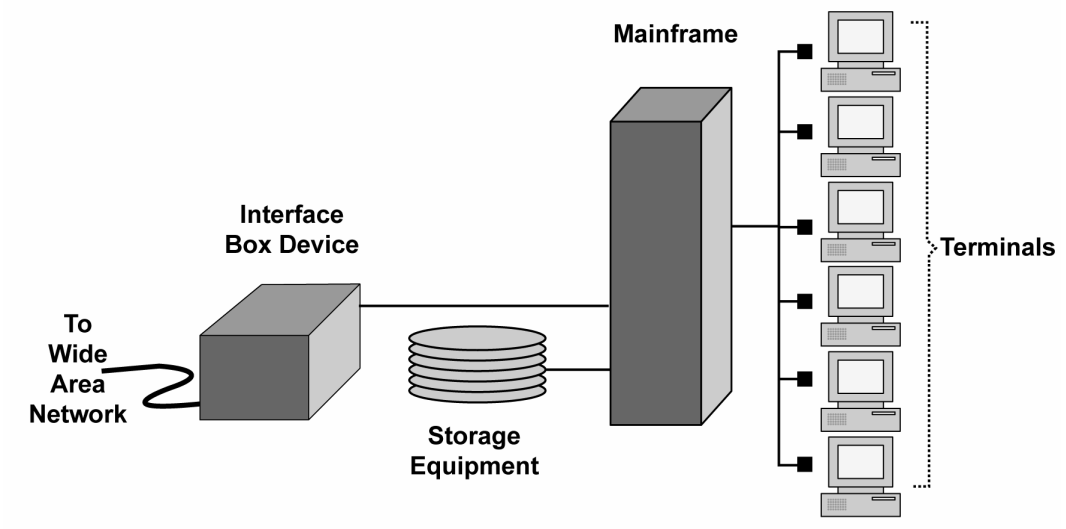


Figure 2.5: Centralised environment

The mainframe computer acts as the brain to the whole environment. All main function processing will be performed by the central processing unit (CPU) that is located in the mainframe. The terminals that are connected to this mainframe, act only as an input and output device that can be directly accessed by the user. These terminals do not have the capability to process (sometimes they are also called dumb terminals). In other words, they do not have a central processing unit. Some terminals have a little ability to process in order to format the resulting output of the process sent by the mainframe.

The brain or the processing that is performed in the mainframe machine is hidden from the user. He can only enter data and instruct the mainframe computer to process, after which he must wait for the processed results to be displayed on the terminal screen. As an example of how this environment functions, let us look at how this environment performs a task in calculating the marks of university students using an application located in the mainframe, as shown in Table 2.2.

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Table 2.2: Example of Using an Application Located in the Mainframe

Step	User Activity
1	Switch on the terminal.
2	Log into the account assigned to the user that is located in the mainframe. Each user is provided a limited storage space in the mainframe machine.
3	Type an instruction to start the application for calculating marks that is located in the mainframe.
4	The application will start within the mainframe. The user is asked to enter the marks at that terminal.
5	The user enters the marks one at a time at the terminal if required (the data can also be accessed from or manipulated in the mainframe storage).
6	The calculation is performed by the processing unit in the mainframe and the results are sent to the user's terminal.
7	The results of the calculation are displayed on the user's terminal. The user's terminal may perform the small task of formatting the result for display on its screen.

Today, the mainframe environment exists only in very large organisations. This is because the production of personal computers, with considerably smaller sizes, higher processing power and much lower prices than a mainframe, has brought about an environmental form that is more economical and flexible. It uses the collaboration of personal computers that is called a distributed environment (to be discussed later).

- **Weakness**: Less user friendly.
- **Strength**: Much safer to use because it can resist attacks from viruses (most viruses are written for personal computers) and hackers.

Nowadays, the role of the dumb terminal is replaced with personal computers that are installed with terminal simulation software to enable them to function as a terminal. These computers can perform terminal functions when they are connected to the mainframe as well as function as personal computers that are capable of performing their own processing functions.

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SELF-CHECK 2.2

List and explain the strengths and weaknesses of the mainframe environment.

2.4.2 PC Environment

The PC environment, also known as the peer-to-peer environment, is a processing environment that is different from the mainframe environment in terms of the distribution of its processing power (refer to Figure 2.6).

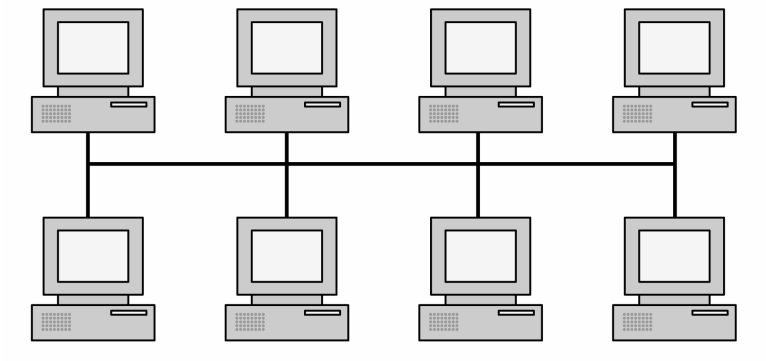


Figure 2.6: Peer-to-peer environment

Its architecture normally consists of the joining of personal computers that are connected, but each one has its own processing unit. A single computer can send data or information to other computers in its environment and the processing work is performed in each separate computer. In certain situations, the data or resource may be placed in a standalone external storage that is shared by all personal computers. Normally, this architecture operates in a LAN network that uses an operating system that is suitable for this PC environment, such as Windows 9x (95, 98) and Windows XP.

- **Weaknesses**: Lacks the high security and integrity of a mainframe system and efficient device coordination capability.
- **Strengths**: New functionalities can be added, offers scalability (ability to handle an increased load) and effectiveness.

This architecture is appropriate in situations where the sharing of data becomes a necessity. However, it does not have the complex software that enables different programs to perform a single function simultaneously.

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2.4.3 Distributed Environment

A distributed system is the collaboration of the strengths of the two environments previously discussed. It joins together several computers that are said to be autonomous, which means that the computers have their own processing power so that they can process when required or stop a process at any time without being controlled by the control centre. The computers involved must work together in order to fulfill the needs of the organisation. An illustration of this environment is shown in Figure 2.7.

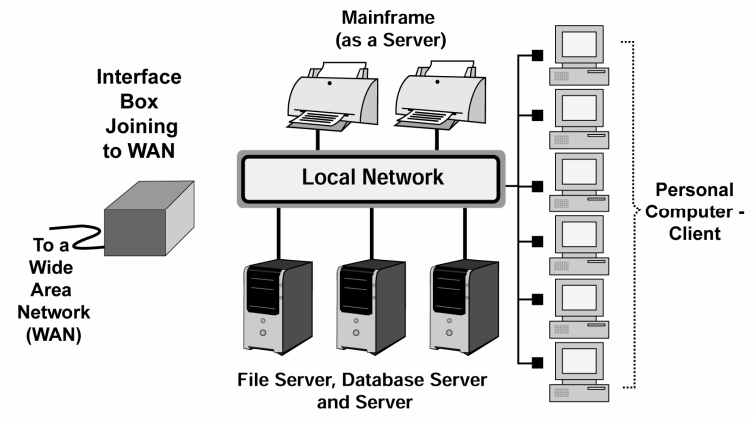


Figure 2.7: Distributed environment

The goal of using this distributed system is to enable a high level of interaction among many different computer systems (not just a terminal any more) for two main aims:

(a) A uniformed sharing of resources among computers that are connected in the network. Even though the data or other resources like certain application programs may be located in different computers in certain networks, a user connected to this network should be able to access these resources without having to know where they are located. He only needs to state the resource that is needed and the application software that manages this distributed system will obtain it. This is characteristically known as being transparent.

(b) Enables each computer to cooperate in implementing smoothly a certain business function in a single organisation. This function is broken down into smaller functions and distributed to different computers. This form of high-level interaction can be achieved with the use of distributed system management software that is becoming more advanced.

A distributed system can be implemented in several different forms based on the same basic idea. These forms include:

- Traditional distributed architecture (file server)

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- Client-server architecture (including internet and intranet)
- Enterprise architecture

The first form has a lower rate of integration between machines compared to the third form.

(a) **File Server Environment**
In this architecture, files are computer program applications that are placed in a special computer. Other computers are connected to it and share these program applications when required.

Functions:
- Manage the sharing of these program applications.
- Server will send the whole file to the client.

Advantage:
- Saves cost by avoiding the need to buy a software application with a separate licence for each client computer from the vendor.

(b) **Client-server Environment**
This environment operates by dividing the involved computers into two groups, which are clients and servers.

Function:
- As a server, the database manages the data requests from the clients by obtaining the requested data from the database file and sends the data (not just a single file) to the client.

Advantages:
• Suitable for use in medium or large organisations.
- Appropriate for use in situations where the size of communication channel (bandwidth) becomes a critical limiting factor.
- The end user has more freedom in performing tasks at his own computer.
- The network is not as busy as the first architecture.

(c) **Enterprise Architecture**
This architecture is used in large organisations and has different branches. The integration of machines and rate of transparency are higher compared to the other architectures.

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Function:

- Contains a system application that can manage the integration among different types of software and make them seem to function as a single large software entity from the user's perspective. With this, each of the applications that may be functioning on different computers works together as a single large system to fulfil the needs of the organisation or enterprise.

Advantages:

- The user feels as if he is using a single system.
- Enables all organisational resources that may be located in different LAN networks to be accessed by all users transparently.
- Information usage becomes widely accessible and simple.



ACTIVITY 2.2

Compare the three forms of distributed system environment in terms of functions and advantages. Give an example for each.

SUMMARY

- The need for information technology architecture has become the supporting structure or platform for the implementation of an information system.
- There are three main forms of architecture, which are, centralised processing architecture or based on a mainframe, peer-to-peer architecture or PC architecture, and distributed processing architecture.
- However, the trend today is leaning towards the use of distributed systems. In the following topic, you will be exposed to the components and functions of the computer as well as the use of input and output devices.

KEY TERMS

Hierarchical structure

Information architecture

Matrix/Multidimensional structure

Project-based structure

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Topic 3 ▶ Information Technology Management

LEARNING OUTCOMES

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

1. Identify the goals of information technology management;
2. Assess the steps that should be taken in information technology management; and
3. Appraise the organisations that are involved in information technology management and manage them.

▶ INTRODUCTION

Today, the importance of information technology to many organisations can no longer be denied. However, not all implementation/use of information technology in organisations or business companies has borne fruit as hoped. There have been many cases where reliance on information technology without any comprehensive form of information technology management has resulted in negative effects, such as decrease in profits and operational turbulence in performing the daily activities. For example, the failure of information technology caused the operations at the new Hong Kong airport to be halted for several days. A similar occurrence was experienced by the company Hershey Foods in the United States in 1999 when the failure of newly installed information technology caused losses and a fall in profit that amounted to more than US$20 million during the third quarter of that year. This scenario made the issue of information technology management very critical.

In general, the aim of management is to stabilise the technology that is being managed so that it can be accessible and at the same time enable the technology to be adapted to the current context of change. This situation is the same for information technology management. In the context of information technology, the changes that occur cause the management of information technology to develop according to needs that go beyond the boundaries.

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In this topic, we will discuss the important aspects of information technology management.

3.1 GOALS OF INFORMATION TECHNOLOGY MANAGEMENT

Briefly, the goals of information technology management can be divided into two parts:

(a) **Ensuring continuous technology in a stable condition**
Stability is measured by consistency and reliability. Consistency enables the technology to be used with an interface that is uniform wherever it is accessed from. Reliability is the capability of the technology to guarantee that its performance at any given time is as it should be at any other time.

(b) **Ensuring that technology can be adapted according to changes that occur**
Change is inevitable for advancement. Hardware technology and computer software change relatively quickly. This change will create problems for the user if proper management and planning are not performed. The question that arises here is how can a person manage the information technology requirements according to the changes? The answer is the changes in technology that will happen needs to be anticipated and planned even earlier.

3.2 WHAT IS MANAGED?

It is thus necessary to understand that information technology management involves not only the activities of managing hardware and software. Information technology also covers its knowledge workers, users of the technology, and the data used in the technology. Therefore, the management of information technology involves the management of three critical aspects, which are:

(a) Managing information

(b) Managing information technology infrastructure

(c) Managing knowledge workers

3.2.1 Managing Information

Information today is considered to be the capital of an organisation. It has a value or price that is unique to itself, and becomes a commodity that is bought and sold. Today, information is considered crucial to an organisation, just as life is crucial to human beings. Therefore, companies now have special officers to manage the information in their management hierarchy, who are known as Chief Information Officers (CIO).

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The goal of information management is to enable a certain organisation or institution to have the most effective method of obtaining information that is:

- Accurate;
- On time; and
- In the correct form.

The issue of information management covers the challenge of maintaining information access that is accurate and consistent at all times. Another related issue that emerges is how long certain information needs to be kept before it becomes outdated or useless.

(a) **Accurate data access**

(i) Covers the need to access accurate information that fulfils the requirements that can enable the tasks to be carried out effectively and efficiently.

(ii) Has to be accurate and consistent.

(b) **Timely or on time data access**

(i) Ensures the required information can be accessed at the time it is required with the speed that is desired.

(ii) Information that is considered very valuable may be rendered useless when a lot of time has passed. Example: stock market information.

(iii) Needs knowledge workers so that they can access the information when required in order to complete their tasks.

(iv) Customers also need the ability to access the required information such as information about the products that are offered and other similar information at the required time.

(v) The challenge to the management is to ensure that the technology used will be able to fulfil these needs.

(c) **Correct data form during data access**

(i) Needs information to be presented to the user in the required form.

(ii) The upper management may need important information in graphical and statistical forms apart from the required analysis.

(iii) Personal information on employees may have to be detailed and include a photograph.

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(iv) The correct form of information enables the use of the information to increase, and saves the reader's time as well as reduces the possibility of errors from happening.



ACTIVITY 3.1

1. What is the role of the Chief Information Officer (CIO) in the information needs of an organisation?
2. In your opinion, is the CIO needed in an organisation? Why? State your reasons.

3.2.2 Managing Information Technology Infrastructure

As previously discussed, information management must fulfil the requirements from the perspectives of accessing correct information, retrieving information at the right time and also in the correct format. These requirements cannot be achieved without the appropriate supporting technology. To achieve this, the use of technology to support the information needs of an organisation has to be managed well.

In brief, information technology management covers several requirements, such as:

(a) Control over the information technology components in the organisation. This control includes the need to ensure that the cost involved is not wasted without achieving the expected results. In addition to this, it must be ensured that the components of information technology from many types of hardware and software can collaborate and communicate smoothly, proficiently and transparently.

(b) Organisation of information technology components to avoid negative social or health implications on the workers involved. The use of computer hardware can leave a marked effect on certain health aspects of the user, especially if there is continuous exposure. Research has shown that several forms of ailments like headache, neck strain and eye strain are related to computer use. In addition to this, there are social issues (which will be discussed in the topics to come).

(c) Taking the required steps to ensure that all possible or foreseeable disasters do not prevent the flow of information that is needed. Every organisation must have its own disaster recovery plan in the event of a disaster.

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3.2.3 Managing Knowledge Workers

Workers with certain abilities, experience and knowledge form part of the important asset of the organisation. These workers have knowledge gathered from their work experience that mostly cannot be stored in a database or by using information technology. The management of this type of workers will ensure that the organisation can guarantee that they can function to their full potential. With this, the organisation can achieve good results through their service to the organisation.

The management of these workers generally involves human-related issues, like ethics and difference in culture. These issues will be discussed in the topic relating to the social and ethical effects of using information technology (Topic 4). An issue that we will discuss here is telecommuting to increase productivity. Workers do not need to be physically present at work to actually perform work. Today, this form of working is becoming more widespread and the number of workers involved is also increasing. Telecommuting implementation requires detailed planning and it involves issues like worker monitoring, technology used, training on technology usage, information exposure that can be accessed externally, and change management.

3.3 MANAGING INFORMATION TECHNOLOGY ORGANISATIONS

The trend for managing a company's information technology organisation today is by adopting the combination of a centralised and a non-centralised control infrastructure. This development follows the change in the computing trend. The change to this form of distributed technology has caused the organisational structure in managing information technology to become distributed as well.

The use of a distributed system has caused the resources of computers to be distributed to different computer systems in the computing platform used. For example: a database is no longer placed in a centralised mainframe computer; rather, it could be in a server computer located in a different department from the client computer that is accessing the database. This causes expert supporting workers of information technology to be divided into different departments, which changes the structure of information technology management that has existed previously.

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3.3.1 Function of Information Technology Organisation

What are the tasks of an information technology organisation? The functions of an information technology organisation are as summarised in Figure 3.1.

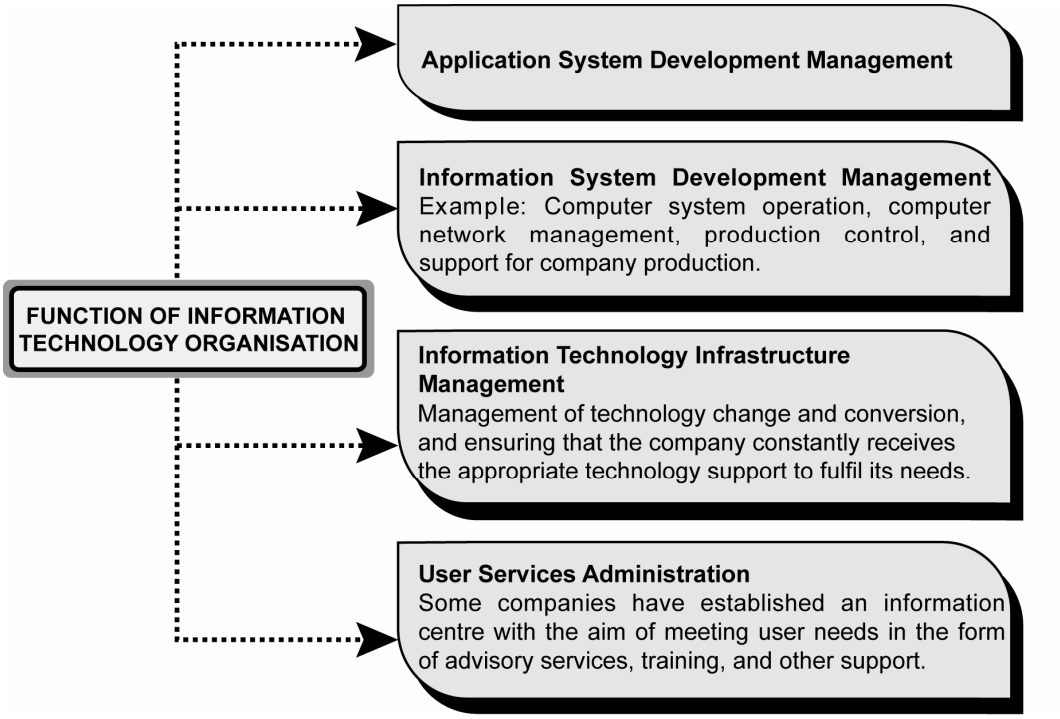


Figure 3.1: Functions of an information technology organisation

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3.3.2 Forms of Information Technology Organisation Implementation

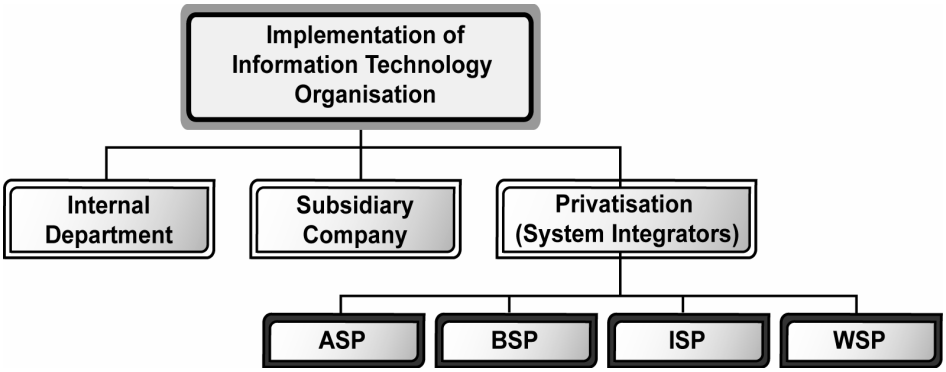


Figure 3.2: Implementation form of information technology support structure

Many forms of implementing an information technology support structure are being used today, including (as shown in Figure 3.2):

(a) Establishment of an information technology department on its own, equipped with a special function to support the implementation of information technology of the company.

(b) Establishment of an information technology subsidiary company as a separate business entity that has two functions – supporting the implementation needs of internal information technology and at the same time, providing services in the form of business to external companies.

(c) Privatisation of information technology support services wholly to external companies known as system-integrators. These companies offer services in several forms such as:

   (i) Application service provider (ASP) that usually focuses on the service needs of a company with regard to software including databases, company resource planning and customer relations.

   (ii) Business service provider (BSP) that develops Internet software which provides software for using the Internet that can be bought through web technology.

   (iii) Internet service provider (ISP) that is a company that provides a service to connect the customers to the Internet and related services.

   (iv) Wholesale service provider (WSP) that provides grouped application packages that are distributed through the Internet.

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In the following sections, we will discuss the aspects of contemporary information technology management that has certain characteristics and coverage. Among the latest information technology characteristics that we will discuss are information technology that is characteristically international and enterprise information technology. In the implementation of both these technologies, web technology is the important mechanism that is the basis for e-commerce and the information technology of today.



SELF-CHECK 3.1

1. What are two main objectives of information technology management?
2. Discuss three important aspects in information technology management.
3. Explain four functions of information technology organisation.
4. Differentiate between the following private information technology support services:
   (a) ASP
   (b) BSP
   (c) ISP
   (d) WSP

SUMMARY

- The goals of managing information technology include ensuring that information technology continues to function and it is able to adapt its functions to current changes.
- It is important to understand the critical aspects of information technology management, as well as the functions and implementation forms of an information technology organisation, in ensuring that these goals are achieved.
- The development of information technology indirectly raises several new issues today. You will learn about security, ethical and social issues in the use of information technology in Topic 4.

KEY TERMS

Application service provider
Business service provider
Information technology management
Internet service provider
Web technology
Wholesale service provider

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Topic 4 ▶ Security, Ethical and Social Issues

LEARNING OUTCOMES

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

1. Identify two types of threats in the use and implementation of information technology in an organisation;
2. Discuss the type of security or control that needs to be implemented in order to face the threats towards information technology;
3. Assess basic ethical beliefs in the use of information technology;
4. Evaluate four effects of information technology use on the social aspect; and
5. Examine the needs and planning of information technology in the organisation in order to achieve optimum positive effects and avoid negative effects.

▶ INTRODUCTION

The wide usage of information technology today has given rise to various new issues regarding the security of information and the social effects. Even though much good and increased productivity have resulted from the use of information technology, it has also left negative effects in several aspects. The use of information technology in certain respects has given rise to problems related to the security of information and the technology used. In addition to this, there are several ethical issues which, if not taken into consideration, will have certain social effects on the general public.

In this topic, we will begin our discussion by understanding the need to plan the security of information technology. We will list the threats that may exist and the form of control or security that has to be implemented to address these problems. After this we will look at the social impact on mankind that results from the

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implementation of information technology. This topic will conclude with a discussion of the basic ethical framework that can be used to implement information technology.

4.1 INFORMATION TECHNOLOGY SECURITY



ACTIVITY 4.1

What do you understand about security of information technology? Discuss.

The aspect of security in using information technology involves the outcome towards the forms of threats that would endanger information technology and the information that is stored within it. What are the resources that require protection and the mechanism to obstruct or prevent these threats from becoming attacks that would endanger the organisation? The introduction of information technology has caused the emergence of a new kind of cyber crime that requires a definition of that term and a new defined standard to control or monitor it.

4.1.1 Threats Towards Information Technology

When security becomes an issue, there must be a threat that should be avoided in order to ensure security. This also requires us to understand the forms of threat that may happen towards information technology. In brief, the threats towards information technology can occur in two forms, intentional and non-intentional.

(a) Non-intentional Threats

Several common forms of threats towards information technology in a non-intentional form are:

(i) Errors in entering data into the technology.

(ii) Bugs or errors in programming. For example, two-third of the telecommunications technology in Singapore was paralysed in 1994 when new software was introduced because the software contained many bugs that had not been detected.

(iii) Mistakes in managing files that could occur in many ways, such as accidentally deleting files, accidentally formatting the disk containing the file, or keeping the file under a name that cannot be found.

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(iv) Carelessness in performing cautious steps or policies that need to be adhered to in an emergency or disaster situation that could cause the hardware to malfunction and render the information technology unusable.

(b) **Intentional Threats – Computer Crime**

Threats that are intentional include that labelled as computer crime. Computer crime can occur in many forms. In declaring the principle behind computer crimes, we will define computer crime based on the definition given by The Association of Information Technology Professionals (AITP). The AITP definition of computer crime covers:

(i) **Usage that cannot be validated**
Accessing, modifying or damaging software, hardware, data or any computer network resources.

(ii) **Exposure of information that is not permitted**
Exposure of individual or organisational information which may cause a tarnished image or loss in the form of money.

(iii) **Unauthorised copying/pirating of software**
It is an offence to buy pirated software be it in the form of a CD or others.

(iv) **Denial of Service – DOS**
Denial of user access to hardware, software or its own network resources.

(v) **Unauthorised information access**
Use or conspiracy to use computers or certain network resources to obtain unauthorised information.



SELF-CHECK 4.1

What is meant by non-intentional threats to information technology implementation?

Do you agree with the categorisation of the offences stated previously as crime? In order to understand this situation further, let us look at several forms of computer crime that have actually occurred.

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4.1.2 Forms of Computer Crime

Today, cyber crime occurs in many creative ways which are sometimes difficult to detect. Because of this, there exist today several special fields that study computer security to prepare a defence for computer technology from these threats. Some of the forms of crime that usually occur are:

(a) **Computer Hacking**

(i) The activity involving an attempt to use a resource in a computer network that is not authorised.

Normally performed by entering the computer technology through a network computer or the Internet to damage or steal data, information or program from another user's computer in various techniques.

(ii) Now it has become a planned activity that involves hacker associations or clubs that will usually share their experience with other members.

(b) **Cyber Theft**

(i) Causes the loss of money through the activity of stealing hardware and data from the computer.

(ii) Stealing data that may cause a larger loss. This is because data is now considered an asset that has a certain monetary value. In fact, the trend today shows that the theft of information or cyber data is a bigger loss than the theft of hardware.

(iii) In the early stages, these cyber thieves were mostly "insiders" familiar with the organisation or institution. With the introduction of the Internet, the cyber thief has widened his scope to cover international theft of information contained within a computer in an organisation.

(iv) There have been several cases where account information from a bank is used by these Internet hackers to transfer money out of the bank through online transactions.

(c) **Trap Door**

(i) This is a technique that enables intrusion into a programming code using a certain information technology technique. Secret codes can be inserted into the programming so that secret and invisible work can be performed by the trespasser.

(ii) Software usually sends certain information to the trespasser that uses special signals from within the code that has been invaded.

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(d) **Time and Computer Resource Theft**

(i) Other than stealing data and hardware, other computer resources that have their own monetary value can also be stolen.

(ii) Computer usage time, which is normally measured using CPU usage time and terminal usage time.

(iii) CPU usage time is the usage time to perform a process like calculations.

(iv) Terminal usage time, also known as input/output time, is the computer usage time to type or perform other interactive operations.

(v) CPU time is valued higher than input/output time.

(vi) Normally occurs during misuse of the computer in working hours.

(vii) A worker who uses the computer to surf recreational websites or for his own personal business needs while working is deemed to be stealing time and computer resource.

(e) **Pirated Software (Illegal Copying)**

(i) Software that is produced and given copyright is an intellectual product protected by law.

(ii) Intellectual copyright material cannot be copied without permission from the holder of the copyright.

(iii) Software that is bought usually comes with a form of agreement that limits its use to within the boundaries of the licence that is given.

(iv) The licence fee usually specifies the number of users that can use the software at one time.

(v) A company that buys a software package normally signs a sales agreement that enables it to make several controlled copies for the use of its employees.

(vi) In Malaysia, the government is currently trying to enforce the act to protect intellectual products by making raids and spot checks at certain premises.

(f) **Computer Virus and Other Damaging Software**

(i) There are several forms of damaging software that can become a serious threat to an organisation's information technology.

(ii) They operate in different forms in order to achieve varying goals.

(iii) These types of software include:

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- **Virus**
  - Software that is inserted secretly and undetected into an information technology unit.
  - Can spread through the use of diskettes or through files sent over the Internet.
  - Produces many copies of itself in order to fill up the memory space and computer storage of the user without detection.
  - Can spread and infect other computers when the infected file is copied into a computer, whether through a diskette or e-mail.
  - Acts in different ways, like filling up storage or memory space, deleting or damaging files, and displaying certain images on the user's screen at certain times. Some of the more popular viruses are shown in Table 4.1.

Table 4.1: Examples of Viruses

Virus Name	Effect
CONCEPT	Word documents, e-mail, deletes files
FORM	Makes a clicking sound, damages data
ONE_HALF	Damages the hard disk, displays its name on the screen
MONKEY	Windows does not function
JUNKIE	Damages files, boot sector, memory
RIPPER	Damages hard disk randomly
Nimda	Spreads through e-mail and through broadband networks

- **Worm**
  - Software that copies itself instantly and enters a computer technology unit in the Internet or computer network.
  - Copies itself many times until it fills up the computer storage space that is linked through the Internet and causes the computer technology unit to become ineffective.
  - Harder to detect when it is performing activities that cause the broadband to be "eaten up" by sending a lot of useless information traffic through the network.
  - Example: "Love Letter" from the Philippines that enters a computer technology unit through an e-mail message that is

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usually sent by a known person. When the user opens the message, the computer will be infected.

- Damages graphic files of the user and sends a copy of itself to all addresses contained within the user's address book that is kept by the e-mail client of the user.

- **Trojan Horse**
  - Illegal software that is secretly absorbed into another software that is being used by the user.
  - Will "sleep" until a certain amount of time passes, and then it will perform the damaging actions when a certain trigger event occurs at a certain time.

- **Salami Slicing**
  - A program that is usually used to steal money from a user's account.
  - The amount of money stolen is actually quite small (third decimal place of a sen).
  - Example: Taking 0.0034 sen from an amount of RM20,000.4434. When the number of accounts is quite large (millions of accounts), then the money stolen will be of a very high value, even though the user is completely oblivious to what is actually happening.



SELF-CHECK 4.2

1. Explain five offences that have been declared by the AITP as cyber crime.
2. How does the worm and virus software bring harm to the user?
3. What is the difference between a Trojan Horse and a trap door?

4.1.3 Technology Security Management

What are the resources that need to be controlled or managed from the perspective of their safety? The resources that need to be protected include:

- Raw data.
- Information.

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- Computer hardware.
- Peripheral devices that are connected with computer technology.
- The information technology used.
- Support software that is used in the information technology unit, like operating technology.

Let us look at how we can manage information technology safety, firstly from the basic concepts and then from the steps that need to be performed practically today that form the safety control of information technology.

(a) **Objectives of System Safety Management**

In general, system safety management can be said to be the effort to control access to technology to ensure the four important objectives are met, which are:

(i) **Confidentiality**

This is for ensuring that data or information is not exposed to others who are not supposed to see it. Executive Information System, Company Accounting System, and Human Resource Management are among the systems that are critical and need to be protected in this regard.

(ii) **Integrity**

This is for ensuring that the information stored can be trusted and that the data as well as the program that manages it is always accurate or functions like it is supposed to. In other words, it represents the actual technology capability for each time when access is made.

(iii) **Availability**

This is for ensuring that technology, data and service in this system can be accessed at all times that they are required by anyone who is allowed access.

(iv) **Adherence to the Rules**

This is for ensuring that all aspects of operations related to this information technology follow all the laws, rules, policies, agreements, contracts and ethical principles used in an organisation.

(b) **Strategies of System Safety Control**

A strategic implementation of a system safety control is very important in building a defence structure against all threats, whether they are intentional or non-intentional. However, it must be stated that building a good safety control infrastructure will involve an implicated cost. Conversely, not building an accurate control feature may lead to a loss which may be even more costly. The middle road is to ensure a sufficient amount of safety

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control within the organisation, not more and not less. To produce an overall control for an information system, our strategy will take into consideration three basic steps, by carrying out:

- Risk analysis;
- Control mechanism implementation; and
- Information audit.

(i) **Risk Analysis**

In order to determine how much safety control is required, a risk analysis of the system is necessary. Risk analysis is a procedure to determine the possibilities of threats and losses incurred from the exposure of technology to certain threats. With this, the most effective and most cost-saving step can be taken to lessen the dangers of exposing the technology to a minimum level. The steps that are involved in a risk analysis include:

- Determining potential threats towards the information technology. Arrange these threats according to priority.
- Determining the resources involved that need to be protected.
- Performing a cost analysis on the loss that could be incurred if these resources are exposed to the risks and if they are attacked.
- Forming organisational safety policies that are suitable which cover the access, emergency plan, backup plan, and recovery plan and testing plan policies.

(ii) **Implementation of Control Mechanisms**

After a risk analysis has been performed, only then can the forms of control be formulated in order to face the critical threats that have been listed. Let us have a closer look at several control mechanisms that are usually implemented in forming an appropriate control infrastructure, and the scope of control implementation that we will implement. From that scope, control of technology safety covers all components of information technology and the components that support the implementation of information technology. By referring to Figure 4.1, we can list the control scope, including the safety control of data, system, and information technology and computer network.

In brief, this control mechanism encompasses the prevention mechanism and recovery mechanism that cover the control of threats that are intentional as well as non-intentional.

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Prevention mechanisms are safety control components that are implemented to avoid threats, while recovery mechanisms are steps that are taken after an attack occurs, where even after prevention has been implemented, a threat still occurs, thus recovery is implemented as shown in Figure 4.1.

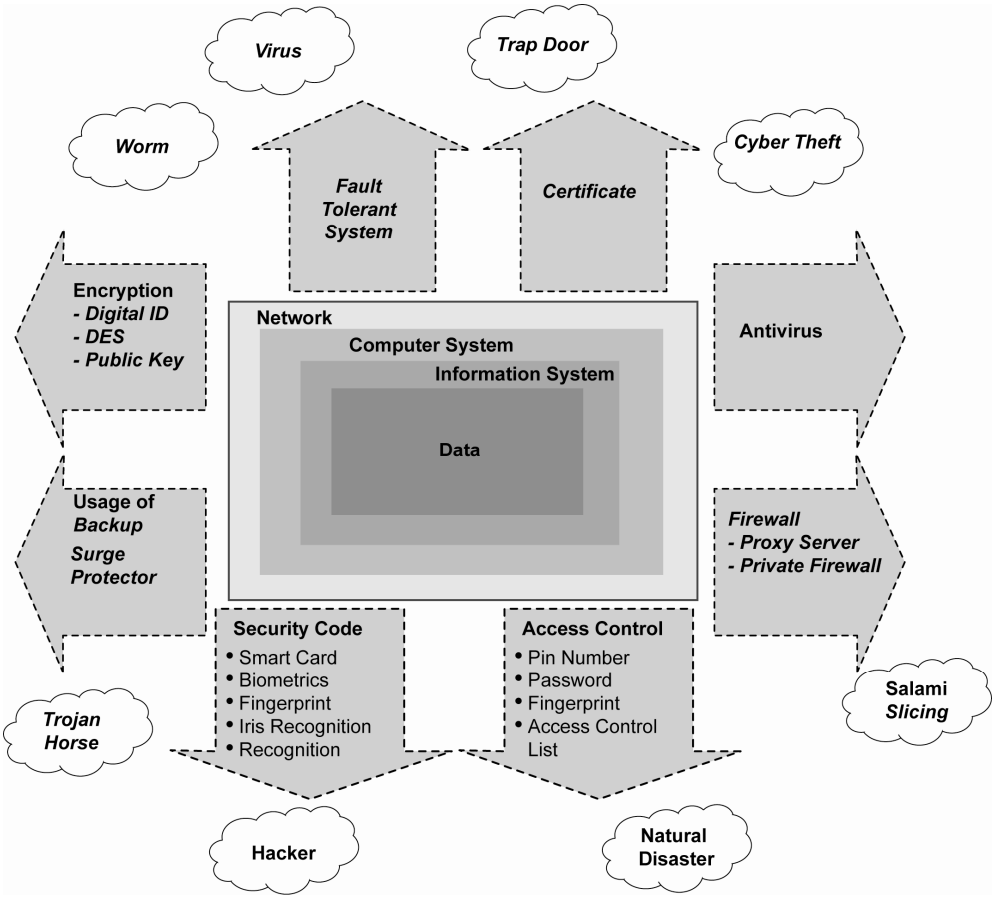


Figure 4.1: Threats and controls in security of information systems

(c) **Non-intentional Threat Control**

For non-intentional threats, several control steps can be implemented which include control of input, output and processing. This control objective generally involves ensuring the correct procedures for data entry, data processing, data storage and information output.

(i) **Input control also includes:**

Using the screen for entering data that has been formatted to reduce the number of mistakes in entering data.

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Validation using certain audible error warnings. When the user makes a mistake in entering data, he is alerted about the mistake by a certain sound.

Software can be used to identify incorrect, invalid or inappropriate data while it is being entered into the system – code, field or transaction that is not valid, outside the limit boundaries, outside the range, monitor of the TOTAL – counting of the total number of records involved – batch count (total count in batches), hash count (for comparison purposes only).

(ii) Output control is aimed at ensuring that the processed results are accurate, complete and distributed in an appropriate manner. Some of the aspects involved are:

- Ensuring that the number of inputs, processes and outputs is balanced.
- Keeping and maintaining a process log.
- Ensuring that only authorised recipients receive the processed output.

(iii) Process control ensures that the data is complete and accurate during the processing stage. After the data is inserted safely into the information system, it should be ensured that the processes function properly. Control over processes is developed to identify the mistakes or errors in arithmetic calculations as well as logical operations, and to ensure data is not lost or not processed as it is supposed to be processed.

Process control can be divided into two: hardware control and software control. Hardware control refers to a special control mechanism that is provided in the hardware for ensuring that the computer process performs accurately.

In brief, the steps that can be taken for hardware control are as follows:

- Produce a controlled total before and after the processing.
- Match the input data with the main file.

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4.1.4 Controlling Computer Crime Security

After briefly looking at these control mechanisms to address non-intentional threats, we now look at control mechanisms that address intentional threats or computer crime.

After prevention, a general control strategy for each component can be outlined as:

(a) **Detection**

(i) When the prevention control mechanism is unable to defend the system, other mechanisms are needed to immediately identify the attackers of the system.

(b) **Limitation**

(i) The effort to minimise the effects of certain attacks or threats as they happen.

(ii) This includes launching immediate steps to enable the important functions of the system to be used as quickly as possible so that loss to the company does not increase when the product cannot be produced.

(iii) Example: Using a substitute system.

(c) **Recovery**

(i) A strategic plan to recover the information system that has been damaged as quickly as possible.

(d) **Correction**

(i) Repair of a damaged system to prevent the problem from recurring.

From the implementation aspect, several protection mechanisms can be used in controlling the information system resources including those contained in the computer network. Some of these mechanisms are:

(a) **Access Control**

(i) Control access to a system by asking for a password, smart card, or using biometric control (fingerprint).

(ii) Antivirus software

- A software application that protects the computer system and application software within it from virus attacks.

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- Blocks any virus contained within any file before that file is used, causing the spread of the virus.
- Scan suspect files and if a virus is found, destroy it.
- The need for updating the antivirus frequently in order to enable the application to detect new viruses. This is done by updating the virus signature components from time to time through the Internet from the company that provides the antivirus.
- New viruses are emerging at a rapid rate today, making it necessary to perform the updating of the antivirus within a short period of time.
- Examples: McAfee, Virus Buster, Norton Antivirus, Symantec, Kapersky.

(iii) Firewalls

- A collection of systems or a system that ensures that certain policy controls for accessing the resources in a computer network are being enforced.
- Play the role of protecting the computer network.

(e) **Security Code**

(i) Password

- The use of security codes like password is a basic mechanism that blocks the unauthorised user from entering a system.
- However, the use of a password requires a good password management system.
- Some emerging issues include the need to change passwords within a period of time, the types of passwords allowed for the user, allotment of a certain password for each user, and the policy in place when a user forgets his password.

(ii) Smart Card

- Used with a reader for validation.
- Keeps information about the user within the card and it can be programmed to perform certain functions.

(iii) Biometrics

- A mechanism that uses physical characteristics of the user to validate him.

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- These characteristics include fingerprint, iris and voice.
- This technology requires a special sensor that will read the information about the physical characteristics of an individual and compare it with a database for authorising the user.

(f) **Fault Tolerant System**

(i) This is used for overcoming problems related to damage within the computer system.

(ii) It involves several process layers, devices, storage and computer software that will automatically replace the system that is having problems to ensure that the process being performed is not disrupted.

(iii) This is applicable for important and critical operations, like in large banks, which normally can afford to have a fault tolerant system provided by a special company that has a layered system in several different places.

(g) **Use of Backup**

(i) Some computer systems are equipped with their own backup facilities like a backup device when there is no electricity, a surge protector, computer data and processed result backup.

(ii) The implementation of a backup in an institution requires a clear and systematic policy to ensure that when a disaster occurs, the computer system will not lose any data or processed results.

(h) **Implementation of an Audit**

After a risk analysis and a defence control mechanism have been implemented, steps to ensure that this defence system is capable of continually providing the required protection are implemented. An audit would implement this need.

4.1.5 Role of Auditing in the Control Process

How does the management of an organisation know whether the control system used is sufficiently effective? The organisation has to perform audits on the system in a systematic and encompassing way.

An information system audit involves the identification of all forms of control responsible for guarding the information system as well as the evaluation of their effectiveness. This includes system quality, software quality and data quality.

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Some of the software quality characteristics in an audit are:

(a) It uses an appropriate system development methodology.

(b) There is an appropriate resource distribution during the development process system.

(c) Software metrics are used.

(d) It gives much focus to the system testing process.

(e) It involves the use of quality devices.

In addition to software audits, the security of the data must be ensured. Some data security aspects that can be implemented include the following steps:

(a) Performing investigations on the quality of data from the user's perspective, like whether the data has fulfilled the user requirements.

(b) Examining the overall files.

(c) Reviewing examples from the data file.

4.1.6 Internet Security

In reality today, conducting business through the Internet has become very profitable. There are several issues in e-commerce, like validation, process of signing the agreement, and payment of the price of purchased goods. These problems are related to security and need particular mechanisms for their implementation. Some of the mechanisms to solve these problems in e-commerce are:

(a) **Encryption**

(i) Modifying the original form of the data into a form that cannot be understood.

(ii) Only valid users have a key to decode the message into its original form. This way, even if the data was stolen, the thief would not be able to read or understand it.

(iii) Several popular encryption algorithms today are RSA (Rivest, Shamir and Adelman), DES (Data Encryption Standard) and SSL (Secure Socket Layer).

(b) **Authentication**

(i) A mechanism that is used to guarantee that the party communicating through the computer network is actually the individual he claims to be.

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(ii) Uses basic encryption techniques in its implementation.

(c) **Information Integrity**

(i) A mechanism to ensure that data sent through the computer network is not copied or modified. Some of these mechanisms are:

- Digital Signature **(Digital ID)**
  - A mechanism that is used to connect the code that is sent with the sender.
  - Similar to the use of manual signatures, a digital signature becomes a validation of that individual in a relationship or agreement in cyberspace.
  - Uses the concept of basic encryption.
- **Digital Certificate**
  - In cyberspace, the digital certificate is used to validate the identity of an individual by a third party. This third party is known as the certificate authority and it will use certain techniques in the encryption in connection with the customer for validating the identity.
  - An example of use is the validation by a credit card authority of an individual for changing data.
  - This validation can be given by this certificate authority.
- **Secure Electronic Transaction – SET**
  - This is a standard protocol for the safety of credit card transactions over the Internet.
  - It is used every time an individual wants to perform a purchase through the Internet using a credit card.
  - The user's credit card information that is sent through the Internet will be encrypted.
  - The use of the digital certificate and digital wallet empowers the credit card controller, the paying bank, and the product seller to ensure that the business transaction can be performed over the Internet.
- **Electronic Money**
  - This is a mechanism of implementing monetary value in electronic form through Internet business transactions.
  - The user is supplied with e-money software.

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- When a purchase is made, this software will produce an e-coin amount. It then wraps this e-coin in a virtual envelope and sends it to the bank. The bank will issue the amount of money that is needed from the customer's account and validate the e-coin value. Validated e-coins will be returned to the user for the purpose of purchase over the Internet.



SELF-CHECK 4.3

1. Describe five forms of protection mechanisms for controlling information system resources.
2. Suggest several mechanisms for solving the problem of Internet security in e-commerce.

4.2 SOCIAL ISSUES IN INFORMATION TECHNOLOGY USAGE

The introduction of information systems and information technology in various aspects of the daily life of society has left many side effects on mankind, whether as an individual or as a society. In the following sections, we will look at several aspects from the social issues that have emerged following the use of information technology.

4.2.1 Threats to Jobs

Many types of jobs which were previously performed by humans are now done by computer systems or machines. Computers have replaced clerks and other workers. For example, with the use of an Executive Information System (EIS), a management can produce executive reports straight from the system for analysis. Previously, this task had to be performed by several clerks or workers. This situation has led to the rising of the unemployment rate.

Even though computer usage has reduced the number of jobs, it has also contributed new positions related to the use of computer systems, such as chief information officer and other related positions. In brief, it can be said that the introduction of computers has removed the positions which entailed repetitious tasks and added job titles that require more skills and intellect. These new positions are filled by people known as knowledge workers.

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4.2.2 Human Relations

There are complaints that the introduction of the computer system has caused relationships between individuals to deteriorate. This is because some operations which previously required human contact or evaluation is now performed autonomously by computer. A computer system does not consider human feelings or logic in performing the tasks that have been programmed into it, unlike humans. Tasks like bill payment, for example, may make the company appear as too strict when it is due, since the system allows no flexibility.

4.2.3 Health Issues

Computer use to perform work in the office can also give rise to new problems, such as work stress, strain to neck muscles, the back or spine, and the shoulders. Constant exposure to radiation from the computer screen can also cause damage to the eyes. In addition to this, monitoring of computer use by the worker can also be said to create excess stress to the worker which may lead to many health related problems.

4.2.4 Threats to Personal Rights (Privacy)

The capability of the computer system to store, process and distribute data is one of the advantages that can facilitate and increase the efficiency of many tasks. However, in general, the computer can also give rise to the issue of personal rights towards confidentiality of information that can be compromised.

Owing to the advanced technology available today, a user surfing the Internet and entering a website may have his personal information captured without his consent. Private user information that is stored in institutional computer systems like credit information and family details face the threat of the information being exposed or wrongly used. From another perspective, there are certain institutions that monitor the use of computers by their workers without these workers being aware of it.

Some forms of offence against the personal rights of individuals are:

(a) Spamming
   (i) Sending of e-mail randomly to a group of Internet users without their consent.
   (ii) Normally used by business companies to advertise certain products.

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(iii) When too many messages of this type are received, they can create problems for the user.

(b) **Flaming**

(i) The act of sending messages containing rude or offensive words to a certain group of computer users, for example, Internet users in a newsgroup.

(ii) Can give rise to sensitive issues, like racial issues, and make the situation tense.

(c) **Computer Matching**

(i) When a user subscribes to an online service, sometimes the information he submits can be 'captured' and stored automatically without his knowledge. This information may become compromised and fall into the hands of others.

(ii) This information can sometimes be used for targeted advertising of products or for sending information that would characteristically attempt to influence the reader into agreeing with a view.

(iii) Matching user information without the knowledge of the owner, the information is performed by the computer system that sometimes generates errors or mistakes that can cause the user problems, like receiving information that should not have been sent to him.

(d) **Internet Usage**

(i) There is a possibility that the business transaction sent through the Internet may be monitored.

(ii) User information can easily be distributed to the whole world instantly.

(iii) In addition to this, there are cases of images or graphics of users that are modified and displayed to the general public with ill intentions.



ACTIVITY 4.2

Information technology has caused a decrease in the number of jobs with the introduction of automation. Think of an opposite argument, that is, how the introduction of the Internet can reduce unemployment?

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4.3 ETHICAL ISSUES

From the language perspective, ethics can be defined as the right or wrong principles held by an individual and they act as a moral agent that is a guide for determining the behaviour code of mankind.

Ethics is a branch of philosophy related to ascertaining right or wrong. The use of information technology and information systems today has given rise to new ethical issues which were non-existent prior to the introduction of computers. What is right and what is wrong in the use of information systems and information technology? This is the basic question that we will address in this section. The value system that decides the right and wrong of using information technology forms that which we know as the ethical code of information technology.

4.3.1 Ethical Issues in Information Technology

What are the forms of new ethical issues that have emerged through the use of information technology? Today, information technology has realised many things that were not considered previously. Computer network technology can transfer information quickly all over the world in a matter of minutes at minimal cost. In this situation, the question of the type of information, which should be distributed and that which should not be distributed becomes an issue. For example, a type of information considered immoral in one culture may not be considered as such in another culture. In another scenario, the use of certain types of software that can monitor the use of information technology by users who are connected to the Internet may compromise their private information. Should the right to monitor be given to the authorities and to what extent should they be allowed to do so? This polemic situation has opened up new questions whose answers must be based on a certain set of beliefs or values. This is known as the code of ethics in using information technology. This set of beliefs will determine what is right and what is wrong in a group or institution and then been followed by its members.

4.3.2 Main Technological Trend that Leads to Ethical Issues

In order to understand further why the use of information technology can cause ethical issues such as the ones stated above, let us review the development of information technology that has led to this. Several situations have given rise to ethical issues in the development of information technology:

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(a) **Exponential advancement of computing power**
At present, it is estimated that the processing power of the computer is increasing exponentially every 18 months. As a result, the main computing operations in business companies are increasing at a rapid rate. Thus, relying too much on computer systems may expose these companies to the effects and performance of their computers. Any mistakes or weaknesses in the data can have a major impact on the organisation.

(b) **Advancement in data storage**
This advancement has opened many opportunities for organisations to store various types of data in a form that is easier to edit, transfer and analyse in electronic storage devices that can be accessed easily and quickly.

(c) **Advancement in data mining techniques**
All the information that is successfully collected can be analysed in greater detail to examine the behaviours of the customers and other aspects. Data mining is a technique that enables the production of desired information through a data searching process from a large database. Through this method, the data related to the analysis can be searched automatically. This has opened the way for widespread information exposure.

(d) **Advancement in networking including the Internet**
It is clear how network technology has changed the access patterns and sending of data today. The user can access data or information directly from his room without anyone's knowledge. The information that is spread anywhere around the world faces the possibility of being hijacked when it is placed on the Internet!

The situation above has raised several new questions in management and business, including the following:

(a) **The question of rights and responsibilities over information**
Several questions related to the rights and responsibilities of the user and keepers of the information in information systems can be stated as follows:

- What are the rights of the individual and organisation over the information?
- What can they defend?
- What about their responsibilities over the said information?

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(b) **Property rights**
How can the control over intellectual property rights be implemented in today's digital world where it is fairly difficult to confirm an individual's copyright?

(c) **Accountability and control**
Who can be made responsible for all the difficulties that befall an individual from the usage of the information system and the wide distribution of information, collected information and property rights?

(d) **System quality**
What are the standards that should be drawn regarding the quality of data and system for guaranteeing individual rights and the safety of the public relating to the problem of data integrity in an information system? To what extent can data about an individual stored in a database be trusted?

(e) **Quality of life**
What should change and what should be maintained during the process of change towards an era of an informed society?

4.3.3 Basic Framework of Information Technology Ethics

Many organisations or institutions that use information technology have outlined their own code of ethics as a guideline for their members or employees in the use of information technology. This code of ethics will be used in deciding whether or not a certain type of behaviour is right or wrong from the perspective of information technology use within the organisation or institution. You may need to form the code of ethics for information technology use in your organisation some time in the future. Let us decide what should be stated in a code of ethics for information technology use.

For the purpose of our discussion, we will use the 2001 ethical framework used by RO Mason and others (refer to Turban, Reiner, Porter page 512). This framework categorises the ethical issue of information technology into four categories, which are:

- Privacy issues
- Accuracy issues
- Property issues
- Accessibility issues

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4.3.4 Personal Issues

Personal issues are related to the protection of the personal rights of individuals in the use of information technology. It has become an important issue and can cause major damages and losses if it is not addressed properly. You can imagine the huge amount of personal information of users including bank information, information about a user's ailment, and financial credit information that is stored in computer systems connected to a computer network whether it is a local area network (LAN) or wide area network (WAN) like the Internet network that can be accessed by perhaps thousands or millions of other users connected to that computer system.

This information can be used to ruin an individual's reputation or it can be used by certain marketing companies to send advertising to the user without his permission. Certain policies and a code of ethics are needed to determine the information that can and cannot be placed in the computer system.

In another scenario, imagine if the authorities are given the power to fully monitor the computer system usage of an individual through certain devices that must be installed into the computer. In a democratic country, this would become a hot issue (as was once brought to trial in the US). A tight monitoring regime may cause anxiety in the investors and scare them off, but a loose monitoring regime would cause wrongful use of computer resources to spread.

The two scenarios above need a guideline to determine the boundaries between personal rights (privacy) and the rights of the public. Some of the matters that may become the rights of the individual in using an information system are:

(a) Personal rights of users those are stored in an information system in the form of a record in a database.

(b) Information about the information system or computer use by a user, the purpose of its use, the sort of information accessed from the Internet, and others.

Several questions that are related to personal rights are:

(a) To what extent can a user of a computer or information system be monitored by the authorities, in relation to the boundary of usage that is considered personal and the rights of an organisation or institution?

(b) What personal information about a user can be made confidential and what information must be made available when requested by other parties, whether the users or the authorities?

(c) What information can be placed in a database (where its security from others' access cannot be fully guaranteed)?

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You as a user of information technology should be a responsible end user. The AITP has drawn up several guidelines for a code of ethics for information technology officers, which are as follows:

(a) Act with integrity – trustworthy, reliable.

(b) Increase professionalism in your field.

(c) Place high standards for your achievements.

(d) Be responsible for your job.

(e) Be concerned about health, privacy as well as general service to the public.



ACTIVITY 4.3

The trend in the development of information technology has given rise to several questions regarding ethical issues. Relate how this information technology trend can give rise to those issues.

SUMMARY

- Threats in implementing information technology include those that are intentional (computer crime) and non-intentional.
- For both these forms, a suitable control mechanism has to be implemented.
- The use of information technology also leads to the basic issue of the code of information technology ethics that must be adhered to.
- The use of information technology has social effects. Therefore, it is necessary to plan the use of information technology in an organisation or the society in order to gain maximum positive results and avoid its negative effects.

KEY TERMS

Computer hacking	Internet security
Cyber theft	Pirated software
Ethical	Social issues
Information technology security	Trap door

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Topic 5 ▶ Hardware

LEARNING OUTCOMES

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

1. Describe the computer hierarchy according to the type and the role it plays;
2. Discuss main components of a computer system and their separate functions;
3. Examine the functions of a central processing unit;
4. Differentiate between main storage and secondary storage from the perspectives of speed, price and capacity; and
5. Assess the 16 types and uses of input devices as well as the types and uses of output devices.

▶ INTRODUCTION

We have discussed the organisation and the support for information technology related to the needs of an organisation. Refer back to Figure 2.1 in Topic 2 which clarifies the relationship between organisational needs, information needs of the organisation, and the software and hardware requirements that will support this information system architecture.

In this topic, we will begin our discussion on computer hardware by looking at the history of computer system development to fully appreciate and understand the development of the architecture that has led to what we have today. You will thus understand why one architecture is better than another and why there exists different capabilities. In order to examine the suitability of a computer system in supporting an information system in an organisation, we will study the choices for classifying different computer systems.

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Subsequently, we will discuss the components in a computer system that consist of a central processing unit, main memory, computer data transport system, input units and output units. Finally, we will end our discussion by looking at the peripheral devices connected to the computer system.

5.1 COMPUTER EVOLUTION

The development of computer hardware can be divided into four generations. The computer generations are pinned to the technological development, where each has drastically changed the nature of computers.

Let us look at the development of computer generations in brief by referring to Table 5.1 below. The timing for each generation is according to the beginning of the commercial delivery of the hardware technology.

Table 5.1: Computer Generations

Generation	Period
First (1946 – 1957)	Vacuum tubes
Second (1958 – 1963)	Transistor
Third (1964 – 1969)	Integrated Circuit
Fourth (1970 – present)	Very large scale integrated circuits (VLSI), the use of a microprocessor

(a) **First Generation**

It started with the use of vacuum tube technology to represent data. Each bit value of 1 or 0 was represented by a single vacuum tube (there were also early computers that worked based on base-10 counting – with the 10 symbol).

The vacuum tube was very slow compared to the processors of today. It consists of electronic tubes about the size of light bulbs, used as the internal computer components. Thousands of such tubes were required that it generated a great deal of heat, causing problems in temperature regulation and climate control.

Problems and disadvantages:

(i) This technology produced a computer of a fairly large size with a very limited ability to process.

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(ii) Vacuum tubes emanated a lot of heat which caused the processor to heat up quickly and could break down if an appropriate cooling system was not used.

(iii) People operating the computer often did not know whether the problem was in the programming or in the machine, due to frequent burnout.

(iv) The language used in programming was machine language, which is more difficult and time consuming.

Figure 5.1 shows one of the computers built during the first generation, the UNIVAC (1951).



Figure 5.1: One of the computers built during the first generation

(b) **Second Generation**

This generation introduced the transistor made from silicon material. A transistor is a type of component that acts as an electronic switch that can be used to produce two values of 1 or 0 (it can be switched on and off using electrical current – no need to press a switch with your finger!). The silicon material is a type of semiconductor that can conduct electricity at a certain temperature even though it is not a metal.

Advantages:

(i) Enable the production of processors (that are far smaller than vacuum tubes) to avoid overheating of the processor.

(ii) Need no warm-up time, consumes less energy, faster and more reliable.

(iii) An easier to use assembly language (also called symbolic language) compared to machine language that uses abbreviations for instructions instead of numbers.

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Figure 5.2 shows the first transistor model that was produced in the United States.

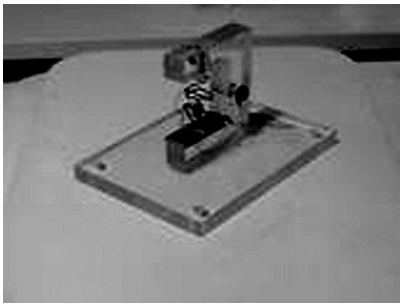


Figure 5.2: The first transistor model invented in the United States

(c) **Third Generation**

In this generation, the silicon transistor was combined in large numbers in the same circuit that was named integrated circuit (IC). A complete electronic circuit on a small chip of silicon may be less than 1/8 inch square, containing thousands of millions of electronic components. It began to replace transistors in computers in 1965.

Advantages:

(i) Able to replace an entire circuit board of transistors with one chip of silicon much smaller than one transistor.

(ii) Reliable, compact and low cost (due to mass production).

(iii) Several programs could run in the same time frame, sharing computer resources.

(iv) Improve efficiency of computer systems – software systems were developed to support interactive processing, where a terminal was used to put the user in direct contact with the computer.

(v) Large computers began to be supplemented by mini-computers, with functions equivalent to full-size systems but slower, smaller and less expensive.

Figure 5.3 shows an early transistor calculator using an IC.



Figure 5.3: An early transistor calculator using an IC

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(d) **Fourth Generation**

This generation witnessed the widespread use of micro computers equipped with microprocessors that are fast and sophisticated and able to perform millions of transactions within a second. The microprocessors are crammed with millions of silicon transistors that act as miniscule switches that represent computer data. Figure 5.4 shows one of the first microprocessors that was built, which was the Intel 4004 in 1971.

Advantages:

(i) Computers in this generation gained dramatically in speed, reliability and storage capacity.

(ii) Common applications on digital watches, pocket calculators, and personal computers.

(iii) Virtually used in every machine in the home or business, such as in cars, copy machines, television sets, bread-making machines, etc.

(iv) Computers today are 100 times smaller than those of the first generation, thus a single chip is far more powerful than the first generation technology.

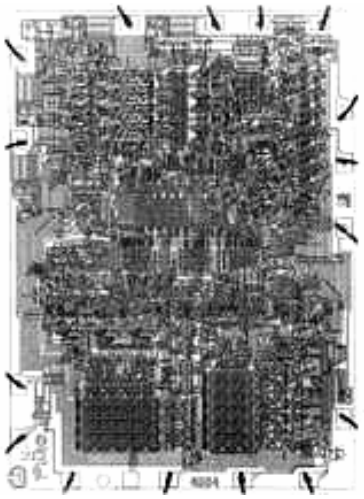


Figure 5.4: Intel 4004 microprocessor

5.2 COMPUTER HIERARCHY

In this section, we will categorise the computer according to size. There are five categories of computers as shown in Table 5.2.

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Table 5.2: Categories of Computers According to Characteristics

Category	Size	Speed (MIPs)	Number of Users	Use
Personal Computer (Micro Computer)	Calculator to desktop computer	1-100	Single	Personal
Workstation Computer	Small cabinet	25-200	1 to hundreds of users	Intensive computer, server computers
Mobile Computer	Small enough to hold in hand	25-200	1 to hundreds of users	Intensive computer, mainly for mobile usage
Mini Computer	Small cabinet to several large cabinets	Hundreds	2000-4000 users	As a central processing computer that terminals connect to
Mainframe Computer	Its hardware can fill up half a room	Hundreds of mips	Hundreds to thousands of users	Same as a mini computer
Super Computer	As big as a normal room	Thousands of mips	Hundreds of users	Research, simulation, involves huge amounts of data and intensive calculations



ACTIVITY 5.1

Name a type of computer that you know and describe its characteristics briefly.

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5.3 COMPUTER SYSTEM COMPONENTS

As mentioned previously, computer hardware components can be divided into two classes, which are:

- Main device components – The main components for a basic computer system required by modern computers to function.
- Peripheral devices - Additional components that can be connected to the open interface of a computer system.

> **A computer system** is a combination or collaboration of main components and peripherals that are used for entering, processing, storing and producing data or information.

This definition identifies the computer system as a black box that receives input, stores or processes it, and produces output which may then be stored again. The functions of a computer system is illustrated in Figure 5.5.

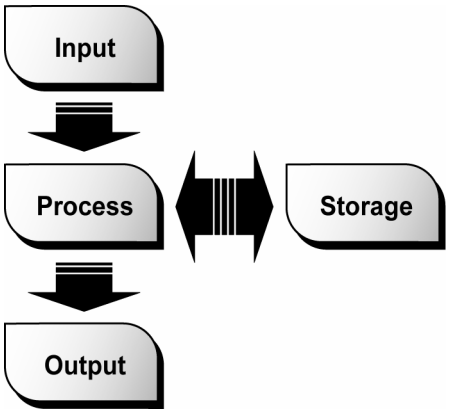


Figure 5.5: Computer system functions

Let us now look at the components of a computer system. In general, these consist of a processor (CPU – central processing unit), storage (main and secondary), input (and input peripheral devices), output (and output peripheral devices) and communication (e.g. data cable). They interact with one another to implement the computer system functions mentioned above. Some of these connections are illustrated in Figure 5.6.

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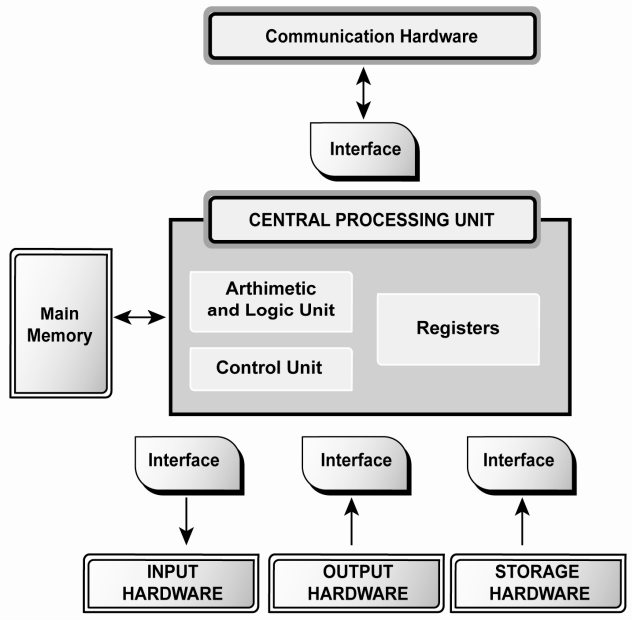


Figure 5.6: Computer system components and their connections

5.3.1 Central Processing Unit (CPU)

The **Central Processing Unit (CPU)** plays the role of the brain of the computer that receives data from the computer memory, and subsequently processes it. There are three other sub-components in a CPU, which are the Arithmetic and Logic Unit (ALU), Control Unit (CU), and registers. These components are explained in greater detail in Table 5.3.

Table 5.3: Three Sub-components of the CPU

Arithmetic and Logic Unit (ALU)	Contains the electronic circuitry that executes all arithmetic (addition, subtraction, multiplication and division) and logical operations (comparison: equal-to, less-than, and greater-than conditions).
Control Unit (CU)	Contains circuitry that uses electrical signals to direct the entire computer system to carry out, or execute, stored program instructions. The control unit does not execute program instructions – it directs other parts of the system to do so. It must communicate with both the arithmetic/logic unit and memory.
Registers	Temporary storage areas for instructions or data, which are not a part of memory. They work under the direction of the control unit to accept, hold, and transfer instructions or data and perform arithmetic or logical comparisons at high speed.

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(a) **Measuring the speed of the CPU**

The speed of the CPU is based on the number of instructions it can process in a second (MIPS unit – million of instruction per second) or the speed of clock cycle controlling the execution of instruction that is performed in one cycle, called a machine cycle. In general, we can consider one machine cycle as performing one instruction (computers today function much faster than this). The period of clock cycle rate is normally measured in Hertz units, which is the frequency measurement or the speed of the clock that controls the CPU. In brief, the unit for measuring CPU speed in Hertz is as follows:

Kilo Hertz (KHz) = thousand Hertz
Mega Hertz (MHz) = million Hertz
Giga Hertz (GHz) = billion Hertz

The processor of personal computers today can function at speeds of close to (or high as) 2 GigaHertz (meaning the speed of a machine cycle is 1/2000000000 seconds!) while the original personal computers during the 1980s had only a turbo speed of MHz.

(b) **Factors that Affect CPU Speed**

Clock speed, machine cycle speed, word length and width of the system bus are always related to CPU speed performance and with each passing year, the speed of each of these components has an effect on the overall speed of the CPU.

Machine cycle speed is also determined by the length of words or the length of data bits that can be transported between the CPU and the memory as well as the width of data that can be transported by the computer bus system. The more bits that are processed, the faster the processing. Other than this, the data that has to be transferred between the memory and the CPU (and also other components) is transported using a circuit called the system bus. The width of the system bus shows the number of bits that can be transported at any one time.



ACTIVITY 5.2

Are there any other factors determining CPU speed not discussed in the above text?

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5.3.2 Computer Storage

In general, computer storage can be divided into two classes based on its characteristics and functions, which are:

- Primary storage – For storing contents for short periods of time, which is during the execution of a process by the CPU, directly connected to the computer system (without a special interface unit like a peripheral device).
- Secondary storage – Considered as a peripheral device for storing information for the long term and it is characteristically permanent.

Figure 5.7 gives an overall picture of all the computer storage components mentioned above. In this section, we will look at both the classes of storage in greater detail.

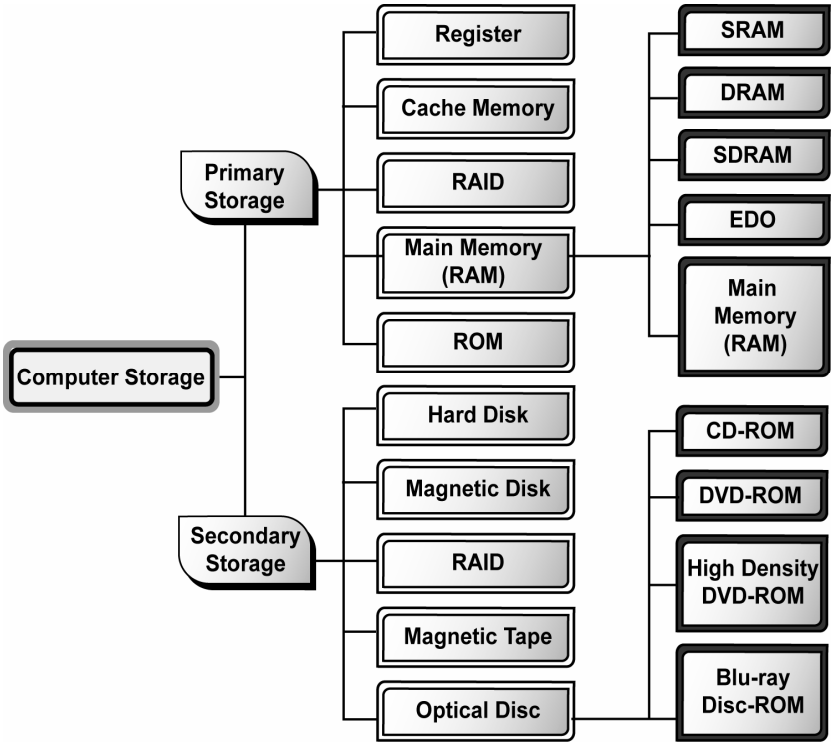


Figure 5.7: Computer storage

(a) **Primary Storage**

Primary storage may consist of several types, which are registers, cache memory, main memory (RAM) and ROM. Table 5.4 explains the types of primary storage in greater detail.

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Table 5.4: Types of Primary Storage

Types	Description
Register	Instant access memory unit for CPU use. Located within the CPU.
Cache memory	To accelerate data access to memory. It is more of a middleman between the CPU and memory. It is faster and of smaller size in memory and bigger than a register. The user only needs to access the data in the cache which is much quicker without having to access the memory.
RAID	Redundant array of independent disks. A group of two or more integrated hard disks that acts like a single large hard disk.
Main memory (RAM)	Main memory space where data is placed before being processed by the CPU.
ROM	Readable memory that can only be read but not written to. Normally contains important computer software that will be used over and over again which must not be damaged or deleted.

(i) **Main Memory**

The main memory is a temporary memory (short term) for the computer system. It stores both data (addresses are also considered as data) and computer instructions before they are processed by the CPU. The data in the memory will be deleted when the electrical current is disconnected from the memory (when the computer is switched off). This is why this memory is sometimes referred to as volatile memory.

Address is a unique number that identifies the location of a byte in memory. Imagine a seat in a concert hall that is identified by a unique seat number, can only hold one person at a time. So does a location in memory, which is identified by a unique address, hold a single byte? The 'seat' can also be empty. The computer references the addresses that contain bytes of data to access data or instructions in memory.

Memory size is fairly important for ensuring the speed of computer processing. In brief, the unit for measuring memory size is in the range of hundreds of kilobytes (in old computers) to several megabytes (in the current computers). A smaller memory size may cause data to be stored and retrieved from memory many more times and this would increase the overall processing time. Having a high speed processor in combination with a small or slow memory will not

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ensure the processing speed because the memory capability will be a factor that will limit the processing speed.

(ii) **Types of Memory**

There are two types of memory, which are read only memory (ROM) and random access memory (RAM). Both these types of memory will be explained in greater detail in Table 5.5.

Table 5.5: Two Types of Memory

Random access memory (RAM)	Data storage part that is characteristically volatile. Data or instructions can be accessed directly.
Read only memory (ROM)	Stores data that can be read only, like certain instructions that are permanent and used routinely in computer processing. It cannot receive any data to be written to it.

Normally, one memory unit will consist of a collaboration of these two types of memory and the larger part would be RAM. The RAM technology that is used today has several variations which are described in greater detail in Table 5.6.

Table 5.6: Types of RAM

SRAM (Static RAM)	Based on flip-flop technology. Faster than DRAM. Normally used as cache memory. Faster than DRAM because it does not have to be re-energised as often as DRAM.
DRAM (Dynamic RAM)	Based on capacitor technology that needs quick electrical current flow in alternate times (every 2 milliseconds) to avoid any loss of data. It is cheap but slower than SRAM. Normally used for main memory only.
EDO RAM (Extended Data Out RAM)	This is a newer type of RAM and it is faster than the old DRAM. Generally, the RAM used in personal computers today is mostly EDO RAM.
SDRAM (Synchronous DRAM)	Much faster and more expensive than EDO RAM.

ROM also comes in its own variations. The types of ROM are shown in Table 5.7.

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Table 5.7: Types of ROM

PROM (Programmable ROM)	This ROM can be re-programmed once only after it is filled with its original content.
EPROM (Erasable PROM)	This ROM unit can be erased using ultraviolet light and reprogrammed. Normally, it can be erased more than once.
EEPROM (Electrically Erasable PROM)	This unit can be erased by directing electrical current flow to it (this is much easier than having to erase it using ultraviolet light).

(b) **Secondary Storage**

Secondary storage devices are included under peripheral devices, depending on the types. Do you still remember the definition for peripheral devices as opposed to the main devices previously discussed in the earlier sections?

The secondary storage technology available today has been developed through several time periods and it is becoming more sophisticated, cheaper and faster. Today, a new personal computer will be equipped with a hard disk of at least 80 to 200 gigabytes. This secondary storage technology has developed, beginning with a magnetic drum, magnetic tape, followed by the use of the magnetic disk, to the era of optical discs.

(i) **Secondary Storage Devices**

Table 5.8 lists several secondary storage devices. These devices are arranged according to speed – beginning with the slowest all the way to the fastest in terms of its accessibility.

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Table 5.8: Advantages and Disadvantages of Storage Peripherals as well as Their Uses

Type	Advantage	Disadvantages	Usage
Magnetic tape	The lowest per bit price	The slowest in accessing data - this is because of sequential access (must begin access from the start of the tape)	Storing data for the purpose of archiving large amounts of data. Normally used by large corporations or institutions only.
Magnetic disk	It is faster because data can be accessed directly at any address the data is located (not sequential)	More expensive than a magnetic tape.	Also used for archiving data. Used in personal computers and up to mainframes.
Hard disk	Small in size but fast.	It is very sensitive to damage.	It is used for short-term storage of data that is frequently accessed by the user. Normally used in personal computers and up to mainframes.
Floppy disk / diskette	Small physical size (can be put inside a pocket). Easy to bring anywhere.	Slow access. Very sensitive to damage.	It enables data to be transferred from one computer to another manually by the user.
Optical storage	Quite large. Lasts longer.	Slower than magnetic storage.	For long-term storage use.
Compact disc - read only memory * Based on optical technology	Price is lower (per bit). Lasts quite a long time. These drives are often found installed in personal computers.	Slow reading process (a variation of WORM can enable data to be written on it for a limited number of times. Rewritable CDs allow data to be written and deleted from the disk 1000 times).	Used in computers to store large amounts of user data for personal use to distribute large sized software
Digital video/versatile disc - read only memory * Based on optical technology	Lasts a long time. These drives are often found installed in latest personal computers. Fast reading process.	Price is higher than compact disc.	Stores data, instructions, and information in a slightly different manner compared to compact disc, which achieves a higher storage capacity.

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(ii) **Data Storage Technology and Media Form**

In general, we can divide the different types of storage media based on their data storage technology and the type of media used. From the data storage perspective, there are two types of data storage technology, namely, magnetic and optical, that are used by different devices, as described in Table 5.9.

Table 5.9: Two Types of Data Storage Technology

Magnetic	Uses polarised magnetism to represent bit 1 and 0.
Optical	Enables representation of bit 1 or 0 resulting from laser transmission on the surface of the media used.

From the perspective of the media used, there are two types – disk and tape (Table 5.10).

Table 5.10: Two Forms of Media

Disk	Magnetic disk, round and flat. Data is stored in units based on tracks and sectors on the surface of the disk.
Tape	Tape form. Example: Magnetic tape.

(iii) **Measuring Storage Size**

How is storage space size measured? The unit for secondary storage like the personal computer hard disk ranges from 1 to 40 gigabytes (how many times larger compared to the unit for memory measure?). This basic unit can be listed, as shown in Table 5.11.

Table 5.11: Unit for Secondary Storage

Basic Unit	Measurement
Bit	1 or 0
Byte	(Byte) 8 bits
Kilobyte	(KB) 2^{10} bytes 1024 bytes
Megabyte	(MB) 2^{10} KB bytes (million bytes)
Gigabyte	(GB) 2^{10} MB bytes (billion bytes)
Terabyte	(TB) 2^{10} GB bytes (trillion bytes)

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ACTIVITY 5.3

Imagine how much text can be stored in a memory space of one megabyte whereby each character uses 8 bits in a storage space. Discuss.

SELF-CHECK 5.1

Explain briefly the differences between primary storage and secondary storage by using appropriate examples.

5.4 DATA REPRESENTATION

We have already discussed computer hardware parts and their functions. Simply put, we can say that the tasks performed by hardware are receiving instructions from software and performing them to produce an output as required by the user. In what form does the computer receive instructions from the software?

All forms of instruction and data that enter the computer must be in the form of a machine language or in a binary form before the computer circuit can understand or use it. Table 5.12 illustrates this.

Table 5.12: Examples of Computer Instructions in Machine Language for Some Processes

Symbolic INSTRUCTION		INSTRUCTION IN MACHINE LANGUAGE (BINARY)		
MOV	AX,X	10111000	00001111	00000001
ADD	AX,Y	00000101	00000000	00010000
SUB	AX,Z	00000101	00000000	00100100
MOV	K, AX	10100011	00000001	00010100
INT	20	11001101	00100000	

(a) **Machine Language**

Today, most of the programming codes for computers are written in a high level programming language that is easily understood by people because it uses word symbols and syntax similar to a written and spoken human language. All programming written in this language must be translated first into machine language before it can be processed by the computer circuitry.

Machine language uses only two symbols, which are 1 and 0, and these symbols are called bits in computer language. The machine language that is

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used by the computer is different from one type of computer to another. For example, the Macintosh using a PowerPC processor uses a different machine language from a Compaq computer using an Intel processor. This, in effect, means that software which has been translated for the Macintosh computer cannot be used directly in a Compaq computer. Table 5.12 shows some examples of computer instructions and machine language in a process.

(b) **Binary Data Representation**

From the perspective of computer processing, we can assume data as the food source for a program or computer software that is being executed. This program or software application will process data to produce the required output. Data should also be transformed into a certain format in binary form so that it can be understood by the computer circuitry. Therefore, many standard formats are used today for these different types of data, as illustrated in the mind map shown in Figure 5.8.

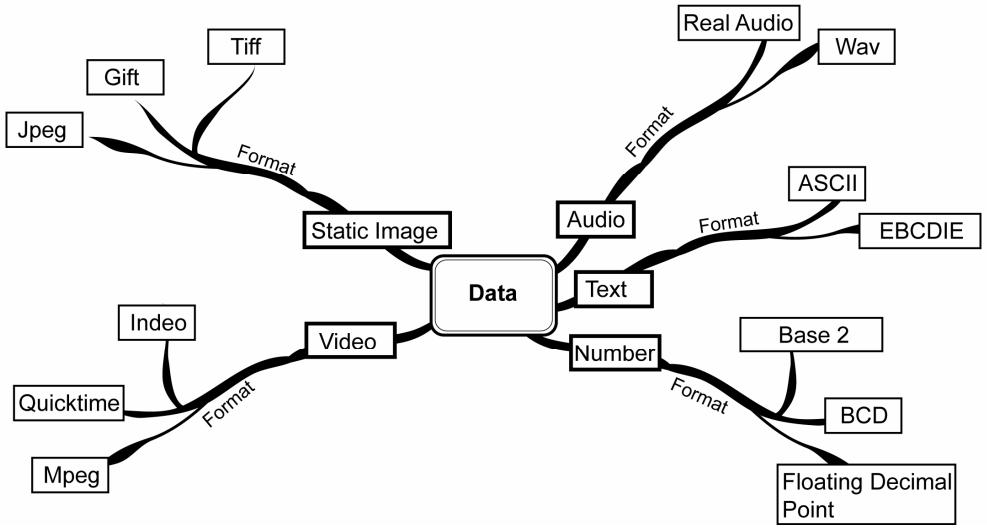


Figure 5.8: Standard data formats

In these binary representations, the numbers 1 and 0 symbols are combined to form different meanings. Each combination must represent a unique value so that there is no ambiguity in determining a value that is represented. For example, to represent text symbols which are characters, 8 or 7 bits (recall, 8 bits = 1 byte) are used to represent one character using the EBCDIC (Extended Binary Coded Decimal Interchange Code) or **ASCII** (American Standard Code for Information Interchange). Table 5.13 shows the representation for the characters 'C', 'A' and 'T' in both these representations.

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Table 5.13: Examples of 'C', 'A' and 'T' Representation in ASCII and EBCDIC

	EBCDIC	ASCII
'C'	1100 0011	1000011
'A'	1100 0001	1000001
'T'	1110 0011	1010100



SELF-CHECK 5.2

How are different data (character, number) represented in a computer?

5.5 INPUT / OUTPUT DEVICES

Most computer peripherals other than secondary storage are classed as either input or output devices, also known as communication devices. Most of these devices are added by the user according to his needs. Let us look at each type of device.

5.5.1 Input Technology

Input devices are peripherals that enable the computer system to receive external input. Several input devices that are commonly used are included in Table 5.14.

Table 5.14: Types of Input Devices and their Usage

Type	Use
Keyboard	Type of device for entering data by typing.
Mouse	Type of device for entering data by selecting.
Joystick	Normally used for computer games. It is in the form of a car gear stick that can rotate 360°.
Touch screen	Enables the user to interact with the computer by touching the screen.
Optical scanner	Translates the image and character into a digital form.
Digital device	In the form of a pen to change an image into a digital form to be saved in the computer storage.

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OCR	Optical Character Recognition - keeps the character and its format.
OMR	Optical Mark Recognition - reads hand-drawn marks such as small circles or rectangles.
POS (Point of Sale)	A terminal that is normally used in supermarkets that plays the role of receiving data while a transaction is being performed. Normally equipped with a touch screen and software that is specifically built to suit the type of transaction to be performed.
BCR (Bar Code Reader)	A bar code reader identifies the products in the shop, factory or warehouse through a striped label stuck onto the products.
RFID (Radio Frequency Identification)	Uses radio signals to communicate with a tag placed in or attached to an object, an animal, or a person. RFID tags contain a memory chip and an antenna, available in many shapes and sizes or embedded in glass, labels or cards.
MICR (Magnetic Ink Character Recognition)	Magnetic Ink Character Recognition – specially created for identifying the name of banks, account numbers and the amount displayed on a cheque. Detects input through the use of a pen - signs using a digital pen-based input.
Digital camera	Enables a picture to be captured in digital form to be kept in the computer storage.
Terminal	The device that receives input that is sent to the mainframe computer or a mini computer that processes this input.
Voice input device	Converts the words that are voiced into digital form.
Sensor	Collects data from the environment that is converted into computer input (examples: temperature, pressure gauge).
Camera, tape recorder	Enable the voice or image to be inserted into a computer for software use or a multimedia presentation.
Microphone	Acts as an input device for voice recognition software.

5.5.2 Output Technology

Output devices enable the user to view or obtain the results of a computer process from the inserted input. Without an output device, a computer system is a device that stores information only. Today, output devices are becoming more advanced in terms of their capability to display various types of output media including audio, video and images. Since the output type required is characteristically varied, the output devices too must be varied. Table 5.15 lists several types of output devices and their special functions.

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Table 5.15: Output Devices

Type of Output	Use
CRT (Cathode Ray Tube)	Computer screen display device
Plotter	Used to produce specific outputs for work normally related to engineering and architectural drawings
Printer	A device that enables the output to be printed on paper
Voice output device	Produces a voice output
LCD (Liquid Crystal Display)	Projects the output onto a screen

Table 5.16 shows the output technology trend in the production of a more effective, faster and clearer output in communication.

Table 5.16: Output Technology Trend: Towards the Production of an Output that is More Effective, Faster and Clearer in Communication

Generation 1	Generation 2	Generation 3	Generation 4
Perforated cards, reports and printed documents	Video display, reports and printed documents	Video display, audio, reports and printed documents	Video display, voice technology, multimedia documents



SELF-CHECK 5.3

List several categories of input and output devices.

SUMMARY

- Today's computers have evolved since the first generation of technology development in 1946. Defining the subsequent generations after the 1970s has become more complicated due to rapid development after the fourth generation.
- Computers consist of two types of hardware, which are main devices and peripheral devices. The main computer devices comprise the central processing unit, main memory, input/output unit and bus system. Peripheral

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devices are connected to the computer system through an interface unit. The computer can be divided into several types, which are the mainframe, mini computer, workstation computer, desktop computer, laptop computer and handheld computer.

- In understanding how a computer works, we covered the components of a computer system – central processing unit, computer storage, data representation, input devices, output devices and the technology of these components.

KEY TERMS

Cache memory
Central processing unit
Computer storage
Computer system
Main memory
Random access memory

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Topic 6 ▶ Software

LEARNING OUTCOMES

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

1. Differentiate between system software and application software;
2. Examine three current issues about software;
3. Assess the types of system software and two types of application software;
4. Appraise the general functions of operating systems; and
5. Evaluate the generations of programming languages.

▶ INTRODUCTION

When using a computer system, you are actually facing the software. Some people define software as the spirit of the computer while the hardware is its body. Just as the spirit cannot be touched, neither can the software.

In this topic, we will try and understand computer software in greater detail. The discussion will begin with the basic concepts of software. Then, we will try and understand the types of software based on several categorisations which can be viewed from many perspectives.

Our discussion in this software topic will be concluded with the approach in producing software. As previously stated, software is the combination of several programmes. Thus, in order to understand the production of computer software, we will discuss two approaches for producing today's computer programmes, which are through the use of software authoring packages and also programming. This brings us to the discussion on computer programming language as an important tool for developing software.

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6.1 BACKGROUND OF SOFTWARE

Computer software is the combination of several programmes that are closely linked to perform certain desired functions of its developer. Computer programs were originally the implementation of algorithms or logical steps to do something. They could be saved to many types of media like the hard disk and floppy disk. However, software is basically instructions that are contained in storage media, and not the actual storage device itself.

From another perspective, software is an interface or the connection between the user and computer hardware. The user's perception of the computer system relies greatly on the software that is used. This is because most users do not understand the architecture or the internal operations of the computer system. Software that displays a good interface and is user friendly will make the use of the computer as an easy task.

ACTIVITY 6.1

What are the possible risks faced by an organisation if it wishes to:

- Obtain a new version of software?
- Maintain the old version?

6.2 ISSUES RELATED TO SOFTWARE

In this section, we will discuss three important issues (Figure 6.1), especially for the manager who needs to make a decision regarding software purchase or acquisition.

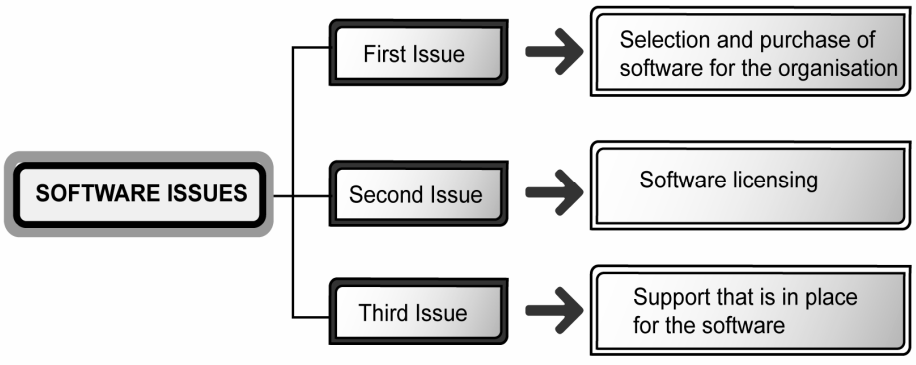


Figure 6.1: Software issues

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(a) **First issue – Selection and Purchase of Software for the Organisation**
This is a process related to the needs of the organisation that cannot be treated separately. Because of this, an information requirement study like Information Strategic Planning (ISP) must be carried out before purchasing any software.

Common mistakes include purchase or selection based on the needs of certain individuals or the advice of the information technology department without a strategic study that covers the needs of the entire organisation. What often occurs is that the decision to use software is based on the technology that is available in the market at that time or the need to adapt the software purchased to the hardware that was previously bought. Hardware purchase needs to be made to support the information system functions, and not the other way round.

(b) **Second issue – Software Licensing**
We often meet users who copy software and use it freely. What is your opinion? Actually, each software product is protected by a copyright by the producer and cannot be copied for use by the masses. This issue has given rise to a heated debate about the extent to which copyrights should cover. Most producing companies prepare a certain licensing scheme as a package bundled with their software for the use of either an organisation or individuals in a computer network and charge a certain rate based on the number of users.

(c) **Third issue – Support for the Software Used**
Normally, the software produced by a company will be maintained from time to time. A new version may contain a small additional programme from the perspective of its capability that may be required by the company. The issue is to ensure that the investment in this new version will result in a profitable return. The user is stuck between investing money for a new version and the possibility that his current hardware may not support the new software and thus new hardware too needs to be purchased. In addition, reliance on a single vendor may also trap the user into a contract or bond that would make it difficult for the user to switch to another product that may be better in the future.

New versions are also usually not stable and may have programming bugs that have not been detected. Being the first user may place that organisation as an experimental black sheep. However, the organisation may be left behind and unable to compete with its rivals if the switch to a new version is not made. This is compounded by the possibility that the producing software company may not support the old version that is still being used.

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Therefore, the new version may help place the organisation ahead and leave its rivals in the dust.

SELF-CHECK 6.1

1. What is the relationship between software and computer programmes?
2. Explain two mistakes that often happen in the process of purchasing software.

6.3 TYPES OF COMPUTER SOFTWARE

The categorisation of computer software can be made based on three aspects, as shown in Figure 6.2.

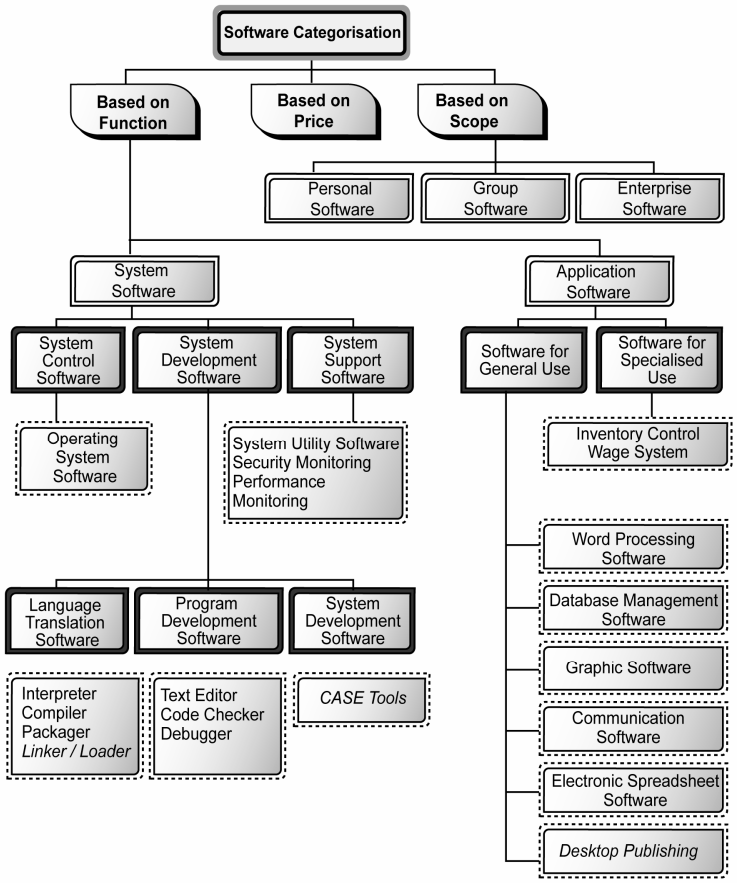


Figure 6.2: Types of computer software and functions

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6.3.1 Categorisation of Software Based on Function

Categorisation based on function leads to the classification of software into two types, which are system software and application software.

(a) **System Software**

System software connects application software and the computer system. It enables the computer system to function according to your needs. System software can be further divided into three parts, which are:

- System control software
- System support software
- System development software

(i) **System Control Software**

What is the important software that you normally use to access the computer system and its resources like the memory and processor? Whether you realise it or not, every time you start the computer, you will be greeted by an operating system software like Windows XP or Windows Vista. An operating system is actually system control software. Its general function is to control your computer system.

What are the specific functions of operating systems? An operating system acts as an operation controller of the computer system and manages all the computer system resources like files, CPU usage and memory space. Examples of operating system software are UNIX, Windows XP, Windows Vista, LINUX and Macintosh.

In brief, some of the roles of the operating system are:

- **As an Interface between the User (Application Software) and the Computer System**

  An operating system provides an interface for the user to enable him to give instructions to the computer in order to perform an operation. Operating systems today are heading towards the trend of using an interface that is characteristically user friendly. The user is able to perform an operation by just clicking a certain icon (small graphical picture that usually represents a certain operation in the computer) displayed on the screen by using a mouse. The use of windows allows the user to maximise the use of the mouse to access data.

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- **Managing Computer Resources**
  An important task of the operating system is also to manage the resources, which are the main components of the computer system that are used by the software to perform its functions. These include:

  - Computer memory space
  - Secondary storage space
  - Processing time of the central processing unit (CPU)
  - Input and output peripheral usage

  Why do these resources need to be managed? Let us review our earlier discussions where a software package consists of the collaboration of various programs. When a software package is used, these programs will also be launched. Each program that performs a certain job is named a process in operating system terms.

  When any software is used, each process competes for the limited computer resources. The operating system will manage the resource access automatically. For example, an operating system will determine which process at what time gets to use the memory space or storage, manage the data addresses in storage memory, and schedule process access to the CPU. This is because there is only one CPU in the majority of personal computers and it can process only a single job at one time. To achieve this, the processes will be allocated a CPU usage time according to a certain algorithm.

- **Managing Data Access**
  An operating system also provides a form of accessing scheme for the data within the computer storage device. In a computer system, data or instructions are kept in files. The operating system will arrange access to these files according to the implemented file system. In most operating systems of today, the file system is built as a file hierarchy. Files that keep the file index of the other files are called a directory or folder. This file system actually forms a logical map of the physical arrangement of these files in the storage device. This logical map is the form of arrangement that will be used by the user to access the desired files. Thus, the user is not burdened with the need to know the physical location of the files in storage. Figure 6.3 shows the file system in hierarchical form in Windows Explorer of Windows 98.

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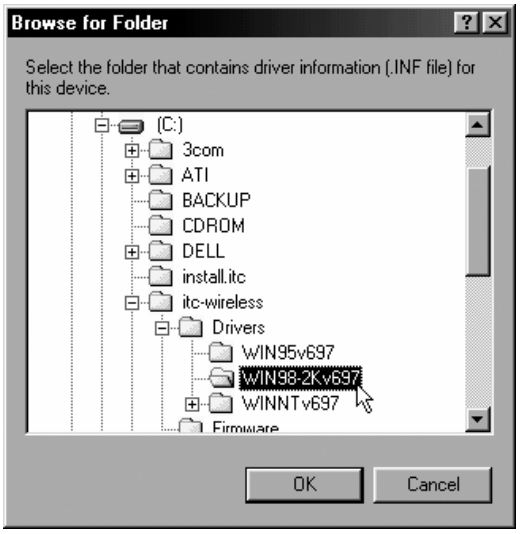


Figure 6.3: A file hierarchy in Windows

ACTIVITY 6.2

When a software application is launched, why are computer resources mentioned?

SELF-CHECK 6.2

1. List and explain three main functions of operating systems.
2. What is meant by the file system being a logical map to the physical arrangement of files?

(ii) **System Support Software**

System support software plays the role of supporting the computer system, for example:

- Ensuring that computer performance is always satisfactory.
- Protecting the computer system from virus attacks and external disturbance.
- Monitoring the status of peripheral devices connected to the computer system.

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Some forms of normal system support software are:

- **Computer System Performance Monitor Software**
  Its function is to monitor CPU usage, memory size that is available or the use of input/output devices, and computer system storage. Usually, it is equipped with the ability to issue warnings to inform the user when the computer system is running out of resources available for use. It also has a graphical interface that can show a graph of the computer resource usage.

- **Computer System Security Software**
  This software protects the computer system from:
  - Attacks by destroyers like viruses.
  - File access by users that are not allowed.
  - Factors that can bring about physical damage to the computer system like an overheating processor.

  Some examples of software packages are antivirus software like McAfee and software that protects computer access by using a password.

- **Computer Utility Software**
  This software is specifically for assisting other routine computer system functions like:
  - Checking storage device configurations (for example, Scandisk in Windows).
  - Obtaining all files that are accidentally deleted.
  - Cleaning the hard disk to remove files that are no longer needed.
  - Compacting the files in the hard disk space to provide extra storage space.

(iii) **System Development Software**
This software helps the process of developing an information system. It helps the management to make a decision that is related to the information system within the organisation. Software such as this will automate the important phases in the process of system software development based on certain methodologies. An example is Computer Aided Software Engineering (CASE).

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ACTIVITY 6.3

Visit a computer shop and list out the software that is available there. Determine the type and use of those software packages.

(b) **Application Software**

This software is developed to perform according to the user's needs. We can divide application software into two types, which are:

(i) Specific use of application software

- It is built for specialised use such as for personal, group or enterprise.
- Examples: software for managing the wage system of an organisation, software for managing accounts, or software for inventory control.

(ii) General use of application software

- It is for general usage.
- It is normally called a commercial software package.
- It is developed by certain vendors to enable the user to fulfil his computing needs. The user only needs to obtain the software and adapt it to his needs without having to develop new software. Thus, development, cost and time can be saved.

This is because software price is normally lower compared with the cost of developing new software. However, it does not have the degree of flexibility of the first type of software application. Normally, this type of package is equipped with features that will enable the user to build his own software. Table 6.1 lists the types of general application software that are widely used today.

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Table 6.1: General Application Software

Name	Use	Example
Word processing software	Plays the role of a typewriter – enables the user to produce documents	Microsoft Word, Word Perfect and Wordstar
Electronic spreadsheet software	Enables electronic calculations to be performed	Microsoft Excel and Lotus 123
Database management software	Manages data – storing, accessing and manipulating data	Dbase and Microsoft Access
Desktop publishing software	Used for publishing magazines, newspapers and books	Microsoft Publisher and Adobe PageMaker
Graphic software for presentation	Produces presentation	Microsoft Power Point
Communication software	Helps access to computer networks	
E-mail software	Manages e-mail access to the e-mail server	Eudora and Pegasus



SELF-CHECK 6.3

1. Explain the difference between application software for specialised use and general use, and give examples for each.
2. Why is the application software for specific use said to be more flexible than that for general use?

6.3.2 Categorisation of Software Based on Scope

The categorisation of software based on scope can be further broken down into three forms of software – personal, group and enterprise. These are discussed in Table 6.2.

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Table 6.2: Categorisation of Software According to Scope

Categorisation of Software Based on Scope		
Personal Software	**Group Software**	**Enterprise Software**
• Developed for use by an individual. • Usually used in a personal computer environment with an operating system that is characteristically personal in its management. • Examples: MS-DOS, Windows.	• Used for cooperation among workers within an organisation. • Can consist of two or more users. • Enables the workers to share information and work together in implementing an online project. • Examples: Lotus Notes and Synergy are usually supported by a network operating system like Windows for Workgroup or Novell Netware.	• Used in an organisation like a firm or a large organisation that may have branches located in different places. • Must be supported by a suitable computer network system to enable it to function across branches. • Often functions as distributed software in the form of client-server. • Normally crosses different departments and enables data from one department to be processed as input for another department.

6.3.3 Categorisation of Software Based on Price

You may have downloaded free software from certain websites through the Internet. Many kind-hearted individuals like to share the results of their invention and hard work with others for free. This type of software is called "freeware."

There are also "shareware" software. The user is normally required to pay a low price to the developer of this software. Even though it has a lower quality than the licensed software that is bought, some quality software is still offered at a relatively low price. The weakness of this type of software is that it does not have a support service like licensed software.

6.4 PROGRAMMING LANGUAGES

Programming languages have been the main method for developing software since computers were first developed. Although there are other ways to develop software today, programming uses a language that is more flexible and can

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perform certain functions that cannot be performed by system development tools in commercial software packages. Furthermore, programming languages, which used to be very difficult to understand, have been simplified into languages that are easy to understand now.

6.4.1 Generations of Programming Languages

Programming languages can be divided into five generations. Table 6.3 lists the different programming languages based on the generation as well as examples.

Table 6.3: Programming Languages

Generation	Category	Specific Characteristics	Example
First	Machine language	• Uses binary symbols only (1 and 0). • Difficult to understand and program. • Machine dependent • Faster processing than high-level languages. • Smallest sized programming files.	Intel processor machine language, Motorola processor language
Second	Assembly language	• Uses character symbols. • Easier to understand and program than machine language. • Machine dependent. • Faster processing than high-level languages.	Intel assembler language, Motorola processor language. Among the more recognised packages are MASM (Microsoft Macro Assembler), TASM (Turbo Assembler)
Third	High-level language. • Procedural language. • Object oriented language. • Visual programming language.	• Machine independent. • Procedural. • Easier to understand and program. • Slower than lower level languages (generations 1 and 2).	Pascal, Basic, C, C++, Java, Fortran, COBOL, ADA

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Fourth	4th generation languages include • Data manipulation language. • Database query language. • Report generator language. • Code generator language.	• Not procedural. • No need to specify in detail the steps needed to perform a function. • Easy to understand. • Quick to program. • Biggest sized programming files.	HTML, JavaScript, Smalltalk, Dbase programming language, Access, Excel
Fifth	• Symbolic programming language • Normal language	• Symbolic programming language that uses instruction processing. • Normal language that uses a complex translator that translates into machine language. Not widely used yet.	Example of symbolic programming language: LISP Examples of normal language: INTELLECT, ELF

SUMMARY

- Software is a complementary component of computer hardware. We can divide software into two main types – system and application.
- System software is used to connect application software with the computer system. It is used by the computer system to carry out the jobs of the system.
- Application software fulfils the needs of the user. Software is basically developed using programming languages which consist of low-level and high-level languages.

KEY TERMS

Application software
Programming languages
Software
System control software

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Topic 7 ▶ Database

LEARNING OUTCOMES

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

1. Explain the storing of data in the traditional sense and its associated problems;
2. Discuss how the role played by the database would solve those problems;
3. Assess the database management system;
4. Evaluate the three models of data; and
5. Distinguish between data warehouse, data mart and data mining.

▶ INTRODUCTION

The organisation that pays much attention to the storage and use of data in an effective manner obviously has a competitive advantage. Therefore, the storing and accessing of data has become a process that is valuable in the community, especially in business organisations. With the existence of a data management system that is organised, the manager or all the workers are able to access the required data or information in a manner that is encompassing, quick and guaranteed in relation to its content. In this topic, we will learn about the points closely related to the storing and accessing of data.

7.1 BASIC PRINCIPLES OF DATA PREPARATION AND ACCESS

In order to achieve effective and efficient operations, an organisation needs a method for managing data that is perfect and smooth so that the services provided will have a competitive edge. This is important because every customer

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and user wants data that is accurate, relevant and up-to-date. However, it is still the responsibility of the user to make good and correct decisions. In order to make a good decision, the manager needs to know how to obtain information as well as how to use it appropriately. This is why the organisation needs to emphasise on the aspect of file management to avoid problems associated with loss of files or leaked information, data overlap, updating and others. Good and efficient file management will facilitate accessing and checking of data. Nowadays, there is a method for file management using computer technology that is more popular called database management.

For the purpose of storing data manually or using a computer, a specific and organised method of arrangement is required so that the accessing and checking of data are easy and fast. For example, when someone registers to see a doctor in a clinic, the personal details are recorded in a form that will be placed in a file and kept in a filing cabinet drawer. In order to assist us in our understanding, we will now look at data hierarchy in greater detail.

7.1.1 Data Hierarchy

For file management that uses a computer system, data is arranged in a hierarchical form that consists of **databases**, **files**, **records**, **fields**, **bytes** and **bits**, as shown in Figure 7.1.

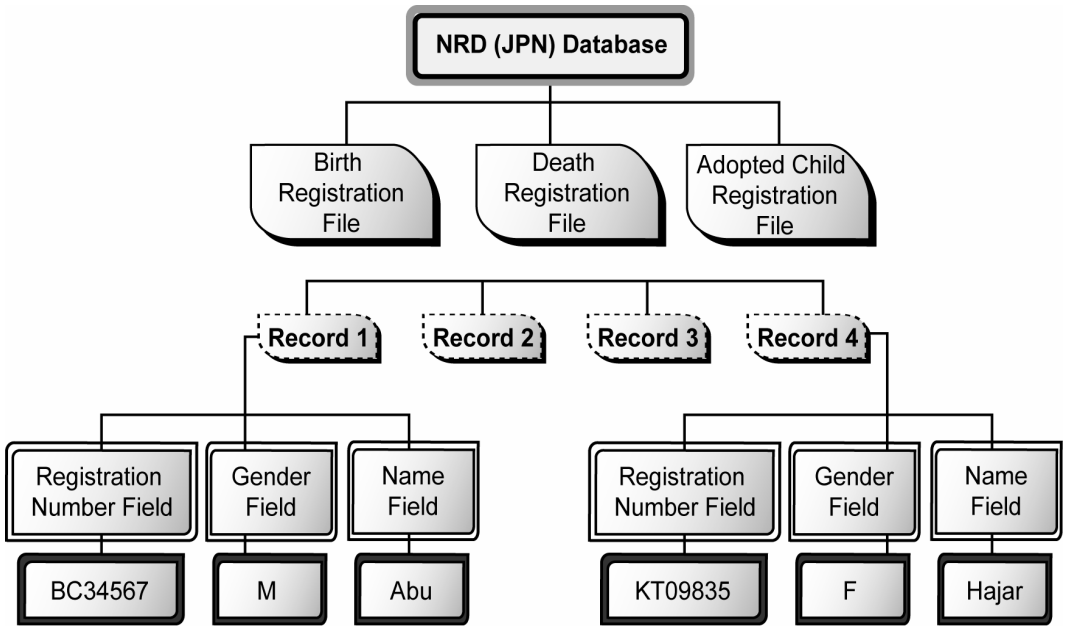


Figure 7.1: Example of database

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Compare this to the analogy of writing, which begins with a character, then a word, a sentence, a paragraph, which then results in a document.

Characters that are represented in the form of bits and bytes can consist of letters, numbers or singular symbols like the full stop and comma. When several of these characters are logically joined together following the requirements into a word, several words or a complete number, a field is formed. In the above example, the examples of a field would be the name field, gender field and registration number field.

When these related fields are combined, a record is produced containing the characteristics for an entity or an object. Examples of entities are people, places, matters or events where the information that is related to it is kept (like information regarding workers, users or products). For example, if the name, employee number, address, position, wage and starting date of service were combined, it would form an employee record.

Each record stored in a database must have a primary key that can distinguish it from other records. This **primary key** is unique, which means that only that record can be represented by that particular key. Examples of primary keys are employee number, identity card number or student matriculation number. The family name or father's name cannot be considered as a primary key because there is a possibility of other people sharing the same name.

The combining of several records will form a single file. Examples of files include a file relating to wage increase, file on giving performance awards, file on promotions and file on employee welfare.

Finally, a logical combining of these files will form a database. The joining of files relating to employee background, work performance, wage report and others will form an employee database.



SELF-CHECK 7.1

Describe data hierarchy. List the data hierarchy from the smallest to the largest.

7.1.2 Storing and Retrieving Data

Files are saved in the computer system by secondary storage media. The records in the files can be arranged in several ways. The way the data is stored will

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determine the way it will be accessed. Examples of these arrangements are as follows:

(a) **Sequential**

(i) Records are kept in sequential form based on the arrangement of certain keys.

(ii) Example: the arrangement of employee records according to the sequence of employee numbers in an organisation. The employee information will be accessed based on the physical sequence it is kept. An example of a secondary storage media that is used for storing data in sequential form is the magnetic tape.

(b) **Direct/Random**

(i) Each record is kept in a random order not based on any arrangement rules. You can access the data in any order without having to consider its physical arrangement in the storage media.

(ii) A field key for a record is used in identifying the physical address with the aid of a mathematical formula.

(iii) It is suitable for use in the following situations:

- For accessing certain records instantly.
- Only when a part of the record is required at a certain time.
- The required records are not in any arrangement.

(iv) An example of a secondary storage media that can be used for keeping data using the direct/random method is the magnetic disk.

(c) **Indexing**

(i) Combines the methods of sequential and random arrangements.

(ii) Enables record access using a sequential or random method.



SELF-CHECK 7.2

1. Explain the methods for accessing data.
2. What is the relationship between accessing data and the way the data is stored?

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7.2 TRADITIONAL FILING SYSTEM

Do you know how files were stored before the spread of information technology? In the past, the file management system or filing system that was in use in organisations was performed manually. This system kept files and information in paper files which were then placed in special cabinet drawers. The files were kept in alphabetical order or according to a certain reference number so that reference and file access can be performed easily.

This traditional method has given rise to many problems:

(a) **Not cost effective** because it involved the storing of many files that are the same within the organisation.

(b) **Data duplication**, or in other words data redundancy, because the same information is recorded more than once.

(c) **Problem of data integrity, which is ambiguity towards the truth of the** information that is stored because of the duplication of data. If no party performs an update, then ambiguity regarding data integrity will certainly arise.

(d) **Inflexibility**, where changes to be made on one record has to be done repetitively at other locations that consist of that same record.

(e) **Low level of security**, due to the non-centralised and non-standardised system that relies very much on how individual departments practise their own security measures on the data.

(f) **No sharing of data**, which causes isolated data, where data stored in separate files in different departments is often difficult to access.

Figure 7.2 is an example on the failure of traditional filling system.

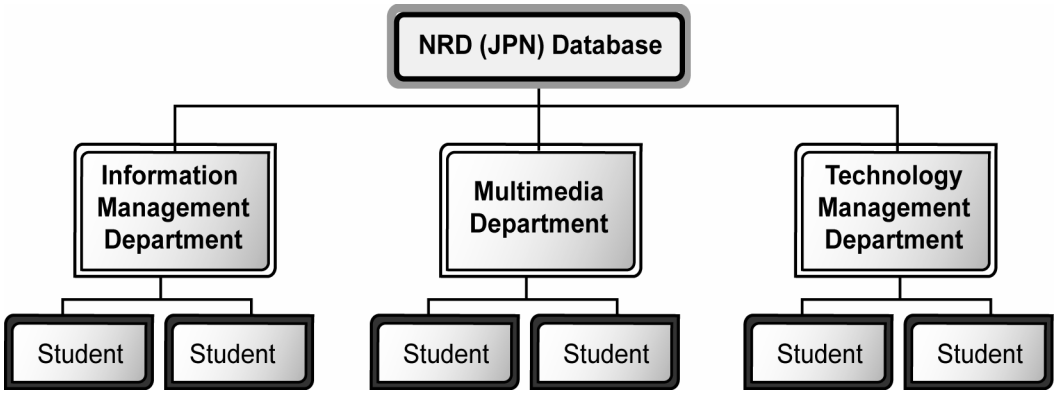


Figure 7.2: Examples of traditional filing system problems

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SELF-CHECK 7.3

Discuss the advantages and disadvantages of the traditional filing method.

7.3 DATABASE

Storing of the same data or information in different locations will not happen if a database system is used. This is because file management using a database will enable data sharing among the departments in an organisation. Therefore, when a student registers, all his personal information will be channelled through the computer system to each department, unit, centre or school that needs it.

7.3.1 Database Development

In order to ensure its effective use, a database has to be designed for the purpose of storing data that is relevant as well as providing a method of accessing the data quickly and easily for modification.

Before producing a suitable database, several basic matters have to be considered. It would be wise to seek the advice of experts in this area, while taking into account the following points:

(a) **Content** (what data should be collected?)

(b) **Purpose** (why particular data should be collected and managed?)

(c) **Access** (which data can be accessed only by users?)

(d) **Logical structure** (how should the data be arranged so that it can be understood by the user?)

(e) **Physical arrangement** (where will the data be stored?)

(f) **Relationship** (how would the data affect and relate to one another?)

7.3.2 Logical Data in Database

In general, databases consist of a collection of files that are interrelated. Where should these files be stored? This question requires attention because it will have a large impact on the access by the user, the time for receiving feedback from a query, data entry, report generation, cost and others.

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If all the files are placed in one location only, it is known as a centralised database. The advantages and disadvantages of this approach are listed in Table 7.1.

Table 7.1: Advantages and Disadvantages of a Centralised Database

Centralised Database	
Advantages	**Disadvantages**
• Saves cost because it does not require too many computers to store the data. • Database administration is easy since the checking or monitoring of data can be performed at just a single location. • Data modification can be done in an ordered manner and under supervision. This helps to produce a more consistent file. • Illegal access or changes in the database can be monitored more effectively because the file can only be accessed through the computer host (the computer that acts as the centralised processing unit in a time shared system or a centralised processing system). • Recovery from disasters is also easily performed.	• If the computer host breaks down, it will disrupt the activities of all parties. • Requires database administrator to monitor and support the centralized data, which incur in cost on resource.



SELF-CHECK 7.4

What are the characteristics that have to be determined in developing a database?



ACTIVITY 7.1

Compare the traditional filing system and database system, with examples to elaborate your points. You can compare by evaluating the database system criteria that solve the problems in traditional filing system.

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7.4 DATABASE MANAGEMENT SYSTEM (DBMS)

In general, the database management system approach involves the following basic activities:

(a) Updating and maintaining the database.

(b) Making available information that is required by the end user by using the related application program.

(c) Preparing an inquiry/response capability that will facilitate the user in performing queries, generating reports as well as receiving almost instant feedback.

(d) Providing means to ensure that only authorised users access data at permitted times, allowing different levels of access privileges to be identified for each field in the database, for the purpose of data security.

(e) Providing variety of techniques to backup and restore the database to a usable form in case it is damaged or destroyed.

The DBMS actually acts as an interface between the application program and the data file. It is a piece of software that:

(a) Helps the organisation to store data in a centralised manner;

(b) Manages it well;

(c) Provides specific programming for performing data access;

(d) Database development. Examples of software include **Microsoft Access** or **Lotus Notes** for the easy development of database and **Oracle 8** or **IBM's DB2** for the development of database that involves bulk and complex data;

(e) Database interrogation. The user can access the information from the database by using a query language or report generator. Through this method, almost instant feedback can be received whether in the form of a video display or a printed report;

(f) Database maintenance;

(g) Application development.

Refer to Table 7.2 for the advantages and disadvantages of a database management system.

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Table 7.2: Advantages and Disadvantages of a Database Management System

Database Management System	
Advantages	**Disadvantages**
• Offers data sharing • Reduces duplicated data as well as increases data integrity • Uses storage space more effectively • Establishes centralised management • Increases wide usage of data • Decreases development and maintenance costs • Facilitates access, control and checks on data • Facilitates modification and updates	• High costs involved in obtaining a DBMS • High operational costs • Costs in hiring skilled workers • High costs involved on compatible hardware and data communication, and their upgrades

Databases are divided into several popular types:

- Operational;
- Distributed;
- Object oriented; and
- Hypermedia.

7.5 DATA MODELS

Accurate and complete information production exists from the connection between several records located within the database. The relationship structure that is in the database is divided into three main structures or models – **hierarchical**, **network** and **relational**. Each model has its own speciality because it establishes a relationship between data in different ways.

7.5.1 Hierarchical Model

A hierarchical model refers to the arrangement of records in levels where each record is located below another record that is considered of a higher level, as shown in Figure 7.3. This model looks like a tree structure that places the "child" record under a "parent".

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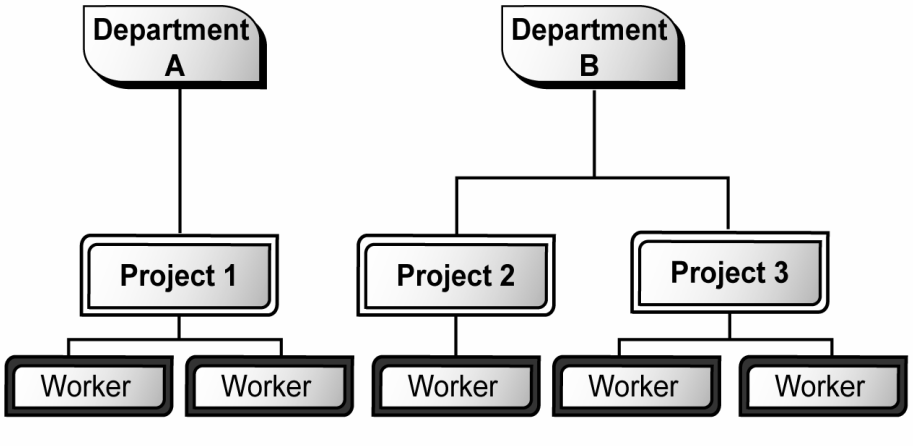


Figure 7.3: Example of hierarchical model

7.5.2 Network Model

A network model is an extension of the hierarchical model. The only difference is that the network model can have more than one "parent", as shown in Figure 7.4.

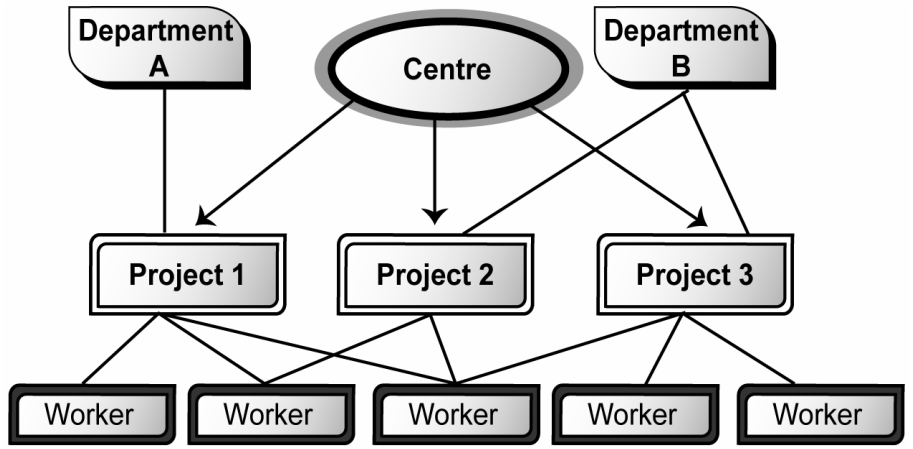


Figure 7.4: Network model

7.5.3 Relational Model

A relational model is one of the most popular models. Data is arranged in the form of a table which consists of rows and columns. The table format is used to facilitate data access and storage. This table actually represents each file in a database. Each row represents a record while each column represents an attribute

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or characteristic of an object or entity. Attributes are characteristics related to an entity contained within a file in a database.

For example, when a student record is created, several attributes will be identified, like name, matriculation number, address and programme, to describe the student entity.

Refer to Figure 7.5. Each record in a table is related to another table by using certain keys, for example, department code and employee code number.

Table 1: Employee File

Employee No.	Name	Date of Reporting	Department Code
859	Fatin Izzati Lani	03/5/02	07
791	Nasrizal Tarmizi	01/12/91	01

Table 2: Department File

Department Code	Department
01	Human Resource
02	Finance

Table 3: Salary File

Employee No.	Salary	Status
859	RM2000	Temporary
791	RM4500	Permanent
234	RM1000	Permanent

Figure 7.5: Relational model



ACTIVITY 7.2

Observe the data management system at your work place. Determine whether it is a traditional or computerised system. If it is computerised, build a database structure model. Identify what type of model it is.

7.6 DATA STORAGE

Table 7.3 and Figure 7.6 show three important points about data storage, which are data warehouse, data mining and data mart.

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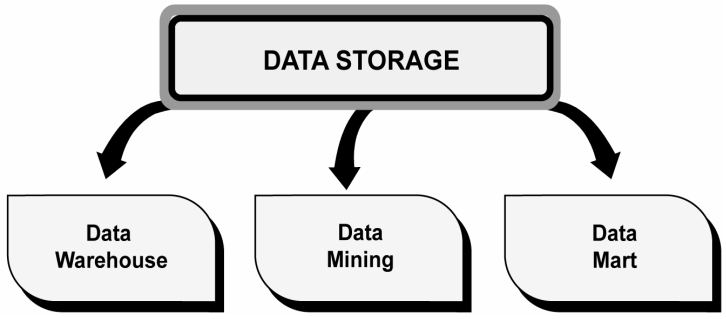


Figure 7.6: Three important points in data storage

Table 7.3: Three Important Points of Data Storage with Description

Data Storage	**Data Warehouse**	• A database that is equipped with query and reporting tools. • Stores old and current data obtained from many systems for analysis purposes. • Resulted from the updating of database and network technologies. Assists the management in making decisions.
	Data Mining	• Data access and analysis from a data warehouse. • Identifies relationships, patterns or trends from a group of data contained in a data warehouse. This makes it easier for a manager to monitor the trend customers favour about a product. For example, whether it is the trend today to buy bungalows, condominiums or other types of housing.
	Data Mart	• A sub-unit of a data warehouse that stores only part of the data in a data warehouse. • For example, a data mart will hold only data related to a certain department from the overall organisational data stored in a data warehouse. • It is useful for a smaller group of workers who need to access data or information in greater detail.

Once the data are in the data warehouse and data marts, they can be accessed by managers, analysts, and other end users. Users can conduct several activities, and these activities are frequently referred to as analytical processing or more commonly as business intelligence.

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Business intelligence (BI) is a broad category of applications and techniques for gathering, sorting, analysing, and providing access to data to help enterprise users make better business and strategic decisions. More advanced applications of BI include outputs such as financial modelling, budgeting, resource allocation and competitive intelligence. Advanced BI systems also include components such as decision models, business performance analysis, metrics, data profiling and reengineering tools, and much more. The most important about BI is that it can be conducted in real time.

Business intelligence employs large numbers of tools and techniques. The major applications include the activities of query and reporting, online analytical processing (OLAP), DSS, data mining, forecasting and statistical analysis.

OLAP is a programming tool that is used to store and channel information from the data warehouse. OLAP also allows users to mine the data from many perspectives. It is a set of tools that can analyse data to reflect actual business needs. In terms of the technology, an OLAP database can be implemented on top of an existing relational database, or it can be implemented through a specialised multidimensional data store.

7.7 MANAGING DATABASE

You are now aware that databases are an important asset for organisations because they are the information and data source or resource used for the daily management of business. If any damage, loss or leakage of data occurs, the organisation will bear a large loss. Therefore, the organisation must place the responsibility on a database administrator who is skilled at managing the database.

This aspect of managing a database is also known as database administration. It is usually handled by an individual or a group of individuals who will maintain and control the database as well as the DBMS, and most importantly, manage the data. Some of the aspects that become the responsibility of the database administrator are:

(a) Controlling the DBMS design, implementing and maintaining the database;

(b) Creating security and control steps of the database;

(c) Monitoring the performance of the database;

(d) Creating and maintaining the data dictionary;

(e) Guiding and training the database users;

(f) Checking backup and recovery procedures; and

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(g) Developing a contingency and emergency plan when facing any possibility of system failure and natural disaster.

SUMMARY

- Database is a structured data storage that is important in an environment based on an information system. This is because the database plays an important role in storing, manipulating and managing data automatically.
- The system that manages the database is called a database management system. A database can come in a relational, hierarchical or network form.
- There are several techniques for manipulating data such as data mining and data warehouse.

KEY TERMS

Data hierarchy
Data mart
Data mining
Data warehouse
Database management system

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Topic 8 ▶ Telecommunications and Network

LEARNING OUTCOMES

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

1. Describe the basic configuration of a telecommunications system;
2. Categorise four types of network;
3. Analyse seven telecommunications applications; and
4. Evaluate the Internet as well as its relation to the organisation.

▶ INTRODUCTION

In our earlier discussions, we used a model to increase our understanding of information system implementation to support the information needs of an organisation.

The implementation of this information system is supported by an appropriate information system architecture platform. The use of an information system in a large organisation covers not only a single building but sometimes also large geographical distances in connecting one branch with other branches. In order to implement this type of information system architecture, the basic infrastructure that enables the transfer of data across vast distances is the computer network.

In this topic, we will look at the computer network and telecommunications technologies in greater detail. We will describe the components that form a computer and telecommunications network, and then understand how each component interacts to enable the implementation of data transfer.

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8.1 DEFINITION AND FUNCTIONS OF TELECOMMUNICATIONS

Do you know what is meant by the term "telecommunications?" In the past, telecommunications was related to telephone companies and their services (e.g. Telekom Malaysia refers to a telecommunications company).

At that time, telecommunications was better understood as the sending of audio or voice through a telephone line or a telephone communication media. This was because at that time, the main connecting media was the telephone line and the main data was the voice. Today, the definition of telecommunications has to be widened because there are many types of data transmitting technology that can be used and there are many types of data other than the voice.

Telecommunications is the channelling of data or information that uses media based on electronics for a certain distance. Today, there are advanced technologies like video-telephone, teleconference, telex, telegram and fax. Telecommunications technology is also equipped with other characteristics that make the channelling of data even easier and more effective for the user.

In general, the functions of today's telecommunications system cover:

- Sending information from the source to the required destination;
- Providing a good user interface between the sender and recipient;
- Channelling messages through the most effective path by determining the data path dynamically;
- Ensuring only the valid recipient will receive the message sent; and
- Implementing tests on the data for checking and correcting errors.

To implement the telecommunications functions, the computer network or data network is built and used by many organisations. For connecting close distances, a local area network (LAN) is used. For longer distances, a metropolitan area network (MAN) or a wide area network (WAN) is used.

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SELF-CHECK 8.1

Explain what is meant by telecommunications.

8.2 TYPES OF DATA NETWORKS

There are four types of data networks, as summarised in Figure 8.1.

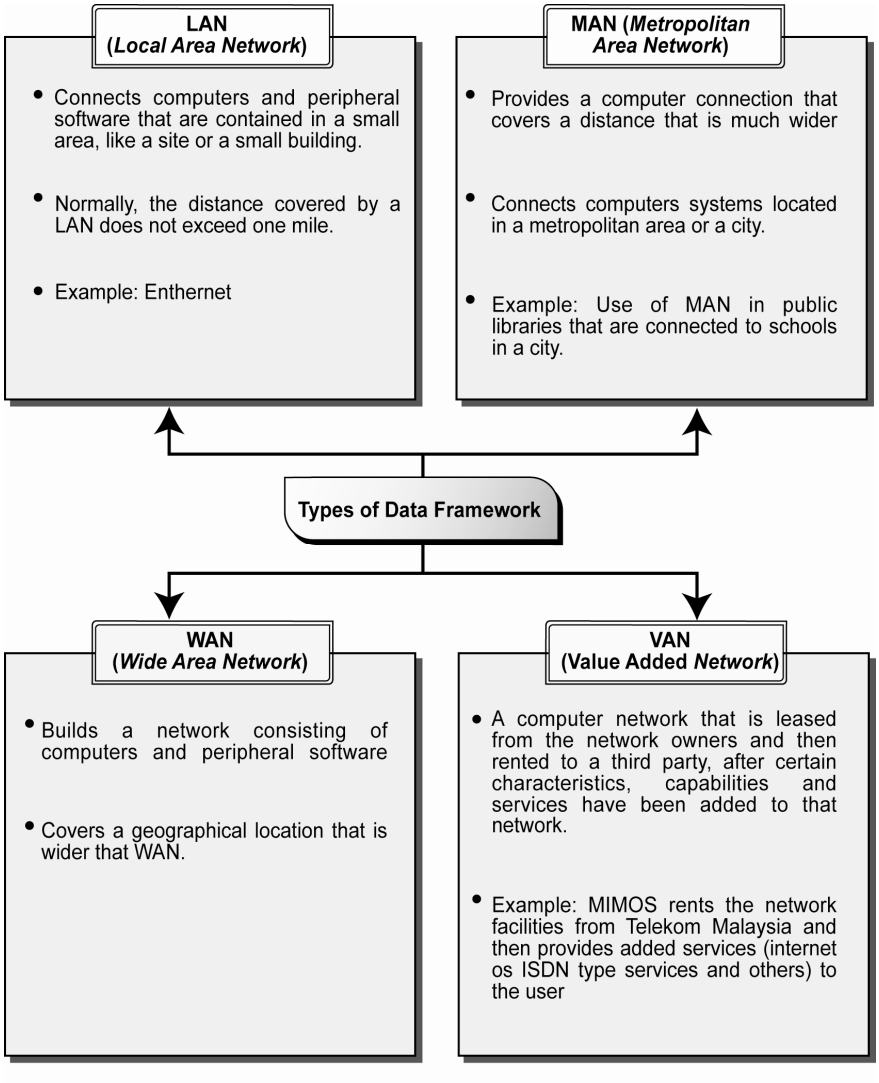


Figure 8.1: Types of data networks

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SELF-CHECK 8.2

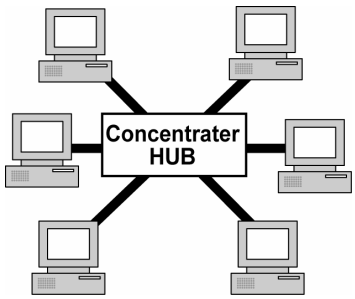
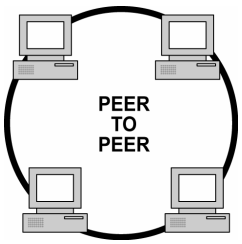
Compare and elaborate on the differences between LAN, MAN, WAN and VAN networks.

8.3 TOPOLOGY OF COMMUNICATION NETWORKS

How are these devices or computers connected in the communication network?

In fact, there are three or four forms of general topology used for connecting computers within a communication network. This is specifically for LAN and MAN networks. A network like WAN is normally developed according to current needs and situations, because it is much more difficult to use a certain topology. Usually, it is formed by a combination of network topologies, using the telecommunications network as a backbone.

The three forms of network topology commonly used are **star**, **bus** and **ring**. Figure 8.2 shows the architectures of all three networks.

(a) **Star Network** • A form of centralised arrangement where the computer host or hub device plays the role of a connector located at the centre of the connection (shown as "Concentrator HUB" in the diagram).	
(b) **Ring Network** • Joins each available node (in another word, "peer") to its neighbour until a ring or a circular shape is formed. • Also known as peer-to-peer network.	

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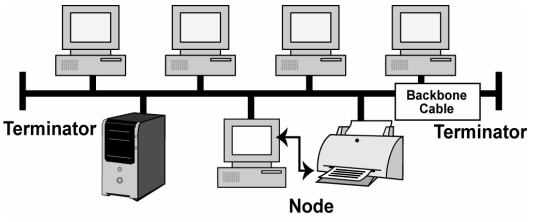
(c) **Bus Network** • Uses a shared distribution line as the communication channel (shown as "Backbone Cable" in the diagram), joining all systems connected to that line. • Illustrated as a road system that connects all nodes (computers and peripherals) to a main road. • This shared line is called bus line.	

Figure 8.2: Types of network topology

Other than these three types of architecture, there is also another architecture or network topology that is known as a **hierarchical network**. This is a computer network arranged in levels with the nodes at the lowest level controlled by the nodes at a higher level, and this level is then controlled by another higher level, and so on.

The different forms of topology have their own advantages and disadvantages. Certain network architectures use certain technologies for their network implementation. For example, the Ethernet network is known for its bus connection.

SELF-CHECK 8.3

List and explain three forms of topology that are normally used.

8.4 BASIC COMPONENTS OF TELECOMMUNICATIONS SYSTEMS

As we already know, a telecommunication network is the combination of several computers as well as the associated peripherals to enable computers to interact with one another. The following are the main basic components needed in a telecommunication system:

- Terminal and computer
- Telecommunications processor

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- Communication media.
- Telecommunications software and communication protocol.
- Communication application software.

8.4.1 Terminals and Computers

Terminals and computers have their own roles in a telecommunications network. A terminal is a device that receives input or displays output in a network. This is because a terminal does not have a processor. A computer is normally used to receive input and display output just like a terminal but the major difference is that a computer can perform data processing. In order for a computer to join a network, it is normally equipped with a network interface card (NIC).

8.4.2 Telecommunications Processor

This is part of the additional device found in a communication network to improve the network and support the data sending and receiving process. Some of the devices normally used as a communication processor are:

(a) **Front-end processor**
This is a small computer for entering, checking or compacting data before it is sent for processing by a mainframe computer that acts as a centralised processor. This is known as an assistant to the host or mainframe computer that is used by the network system.

(b) **Modem**
This is a device for changing signals from analogue to digital and from digital to analogue. It is used to connect a user's computer to the telephone network through dial-up. The information channelled through the telecommunications system is in electrical form, either in **digital** or **analogue** signal form. **Analogue signal** form is an electrical/current signal that is continual and changes according to time. It is used in sending data/information in voice form. The telephone line that connects the sender and receiver computers can carry only analogue signals. **Digital signals** represent data in the form of numbers or other characters. The data/information sent or received by the computer is in digital form.

(c) **Multiplexer**
An electronic device that interweaves the sending and receiving of more than two channels of data through the same line.

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8.4.3 Communication Media

This is a physical media that transfers data from one place to another. In this section, we will discuss several types of communication media that are commonly used. Knowing the types of communication media that exist, the advantages and disadvantages as well as the appropriate media to be used will help you understand the technology or telecommunications network.

(a) Characteristics of Communication Media

What is the best way of deciding which communication media is the most suitable and which is the best? Usually, there are several characteristics that will differentiate one transmitting media tool from another. Some of these are:

(i) Speed of transmission

This is determined by the number of bits that can be transported through the media in a second. So, the total information that can be sent by any communication channel is measured in bits per second (bps). For larger measurements, kilobits per second (kbps), megabits per second (Mbps) or gigabits per second (Gbps) are used.

The term "bandwidth" is often used to describe the rate of speed in sending data through a type of media. Bps is also a unit that is used to describe the speed of this band. What is the connection? Actually, the term "bandwidth" refers to the channel capacity of the transport media. Generally, the bigger the bandwidth, the higher the transmission speeds.

(ii) Noise resistance rate

The communication media that carries the data is actually carrying electrical current or a wave that represents the data that is moved. This electrical current or wave can change from its original form owing to external influences. For example, electrical current in a transmission cable can change when there is another transmission cable located in close proximity that has electrical current flowing through it. This disturbance is called noise. Some transmissions are susceptible to noise while others are noise proof.

(iii) Cost

Some transmission media are more expensive than others. Some not only have higher cost per unit but also higher installation costs than other media.

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(iv) **Transmission mode**

In a telecommunications network, there has to be certain types of transmission, which is **asynchronous** and **synchronous transmission**. Try and guess what is meant by asynchronous and synchronous transmission.

Two connected computers are said to use synchronous transmission if both are ready to send and receive data at the same time. This synchronous transmission can be achieved by using the same timing system. If the time to send and receive is not controlled by the same timing system, it is said to be asynchronous. Normally, asynchronous transmission is transmission at a lower speed where one character is sent at a time, while synchronous transmission is the simultaneous transmission of a group of characters at high speed.

(v) **Direction of transmission**

There are three types – **simplex**, **half-duplex** and **full-duplex**. The simplex direction of transmission allows the transmission of data in one direction at any one time in the transmission media. Half-duplex permits data transmission in both directions but only one direction is allowed at any one time. Meanwhile, full-duplex refers to the transmission of data in both directions at the same time.



SELF-CHECK 8.4

Explain the characteristics of the main communication media.

(b) **Types of Communication Media**

The telecommunications system uses several transmission media like twisted pair cable, coaxial cable, fibre optic cable, microwave, satellite and cellular technology.

(i) **Twisted pair cable**

It is the most used cable, especially in network connections for computers located close to one another. It consists of pairs of copper wires that are insulated and twisted together. The cable wires come in many sizes. Some have only two wires (a pair), two pairs and up to hundreds of insulated pairs of wires. This cable has been used in the telephone system for a long time (see Figure 8.2a).

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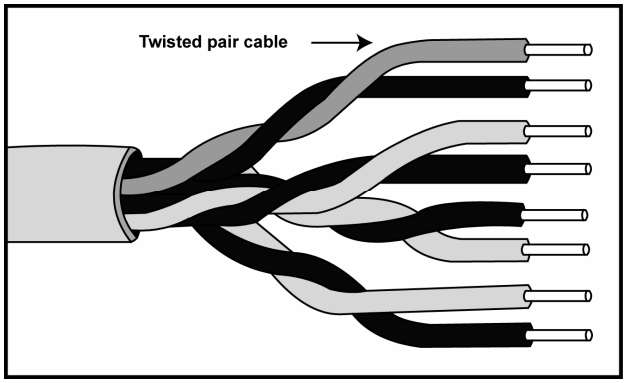


Figure 8.2a: Twisted pair cable

(ii) **Coaxial cable**

If you have observed the cable used for the television cabling system, then you may have noticed a coaxial cable. The coaxial cable is similar to the video cable (normally black in colour). Previously, coaxial cables were often used for connecting computer networks. Nowadays, twisted pair cables are more popular for local area networks because they are cheaper and easier to install.

There are two types of coaxial cables:

- **Broadband coaxial cable**
  - It has a wide frequency range and permits more than one channel to be formed in the cable (imagine that it consists of many small insulated wires that enable a lot of data to be sent at once!).
  - It is used for transporting analogue current only and is normally applied in cable TV systems.

- **Narrowband coaxial cable**
  - It has only a single band.
  - It transports digital currents only and is normally used for computer networks (refer to Figure 8.2b).

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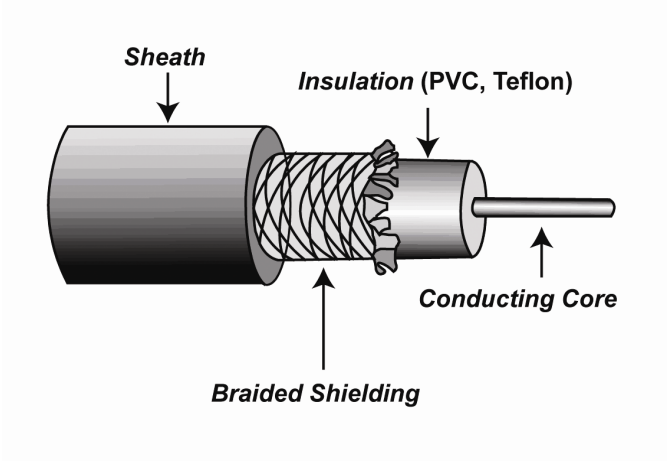


Figure 8.2b: Coaxial cable

(iii) **Fibre optic cable**

Data is changed into a light pulse that will be bounced within this cable using a laser device. Optical fibres are very thin and are insulators. This cable has many special properties compared to the cable made from copper to transport electrical current (refer to Figure 8.2c). The insulation blocks electromagnetic disturbances. This cable is capable of transporting a large amount of data simultaneously and within a short amount of time (light speed). As a comparison, one fibre optic cable can transport up to 32,000 telephone calls simultaneously. This characteristic means that the fibre optic cable is suitable for use in limited places (example: the space in underground pipes that also houses other cables).



Figure 8.2c: Fibre optic cable

(iv) **Microwave**

A microwave is a high frequency wave that receives or sends data through the air. Signals are broadcast in a straight line without any barriers between two transmitting stations or antennae. However, the

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microwave transmission will be blocked if there are any barriers. Therefore, the transmission stations must be located in high places like on roofs of tall buildings or on hills to avoid any physical barrier on the ground. A transmission station can normally transmit a wave for up to 50km before being caught by another station.

(v) **Satellite**

A satellite is a microwave station that is located in outer space. It receives signals from earth-based stations, and after signal amplification, transmits them back in a different frequency. At present, satellites have not been replaced by other media to send data over very great distances. A satellite can transport data more than 40,000km away. Figure 8.3 illustrates the use of satellite and compares it with microwaves.

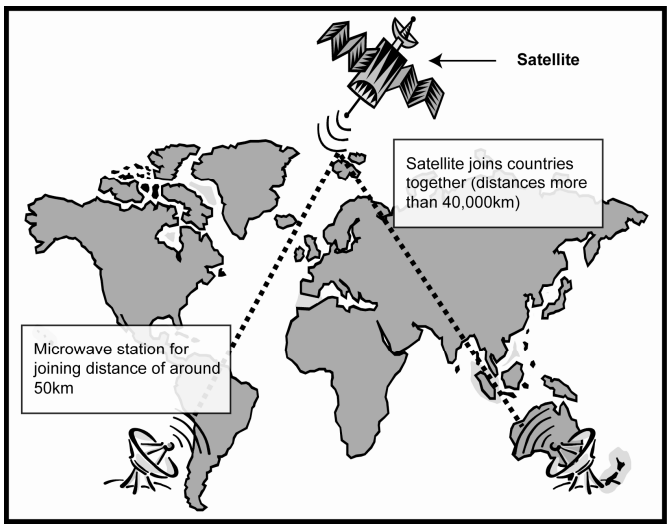


Figure 8.3: Use of satellite and comparison with microwave

(vi) **Cellular technology**

This technology uses a broadcasting station to receive data from users and then sends the data to other users. The transmitter is located in a place that covers a certain area, which is called a cell. Information can be transmitted and received by the user in mobile situations. A cell covers a limited area compared to the microware and satellite. This technology is what connects your mobile phones.

This technology includes infrared, broadcast radio (which include Bluetooth and UWB), and cellular radio.

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Table 8.1 shows the comparison of the types of communication media discussed above, in terms of speed, advantages and weaknesses.

Table 8.1: Types of Communication Media

Media	Data Rate/Speed	Advantages	Weaknesses
Twisted Pair Cable	300bps to 100Mbps	• Low price compared to other cables • Wide use • Easy installation	• Easily affected by electromagnetic fields (noise) • Easy intrusion • Low bandwidth
Coaxial Cable	256Kbps to 200Mbps	• Able to send more data compared to twisted pair cable • Faster • Not easily disturbed	• High cost (bit per unit) • Easy intrusion (better than twisted pair but worse than fibre optic cable)
Fibre Optic Cable	500Kbps to 10Gbps	• Able to transport large amounts of data over longer distances • Very fast • From the perspective of bit per unit, the cost is low • Very secure since it is difficult to break into	• Very sensitive to damage (easily damaged) • Very difficult to instal (normally used for point to point connections)
Microwave	256Kbps to 150Mbps	• Widely used for sending a lot of data from point to point	• Affected by the earth surface that has a lot of hills which act as barriers to transmission • Easily affected by bad weather
Satellite	256Kbps to 1Gbps	• Able to cover a wide area (wider than microwave) • Used for sending large amounts of data over long distances	• Very high cost (billions RM)
Infra Red	115Kbps to 4Mbps	• Easy to use for short distances without cables • Low cost	• The waves can be easily broken into

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Broadcast Radio and Bluetooth	1Mbps to 480Mbps	• Distribute radio signals through the air over long distances, such as between cities, regions and countries, as well as short distances such as within an office or home • Provide flexibility and portability	• Slower and more susceptible to noise
Cellular Radio	9.6Kbps to 2.4Mbps	• Used widely for mobile communications, specifically wireless modems and cellular telephones • Able to connect notebook or mobile computer to a cellular telephone to access the Web, send and receive e-mail, or connect to an office or school network while away from a standard telephone line	• Because of limited number of radio frequencies exist, cellular network providers have to reuse frequencies to accommodate large number of users



ACTIVITY 8.1

Give a brief explanation of each type of communication media in the form of a mind map as well as relevant examples.

8.4.4 Telecommunications Software and Communication Protocol

There are several types of telecommunications software. Some of the more important ones are:

- Network operating system – We will discuss this in greater detail after this
- Network management software – Usually used by the system administrator for monitoring the computer network
- Network security software (firewall) – Used to protect resources within the network from external intruders

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(a) **Network Operating Software**

Do you still remember the operating system software that we discussed in detail in the previous topic? The network operating system functions by managing the systems located in the network, such as data access in the network, processor sharing in the network, and scheduling in the network (just add the phrase "in the network" to all the roles played by the computer operating systems). Examples of network operating systems that are popular today include Windows NT, Windows 2000, Novell Netware, Linux and Unix.

Normally, several components are incorporated together to help the basic functions of a network operating system. For example, the utility to monitor resource use in the network, and data security.

(b) **Protocol**

One of the most important components that we have mentioned is the protocol. The use of the correct protocol is very important in ensuring that the performance of the network is at the optimal level. Most computer network protocols are implemented in the software that is included in the network operating system.

The implementation of protocols is generally done in different layers of protocols to facilitate the execution of the computer protocol. Each layer has its own function and protocol. One of the reference architecture in this layered protocol is the OSI/ISO (Open System Interconnection/ International Standard Organisation) architecture. Today, the OSI/ISO architecture is still used as the general reference; when you refer to any basic literature about computer networks, you will definitely encounter this term. Table 8.2 describes the overall OSI/ISO architecture and examples of the associated protocol.

Do not worry if you do not know all the acronyms of these protocols. They are listed only to inform you about the functions of these protocols when you come across them.

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Table 8.2: OSI/ISO Architecture and the Associated Protocol Example

Layer	Role	Protocol
Application	• Obtains the input from the user, connects the user application with the network protocol	
Presentation	• Formats the data for the user • Implements data encryption for security purposes	
Session	• Starts, manages the journey and stops the session connection between software applications	
Transport	• Controls to ensure that the connection goes as planned (data traffic congestion and others)	TCP, UDP
Network	• Determines the path taken for the data to arrive at the destination	IP
Data Link	• Implements error checking on the data • Forms the data framework format that will be transported through the physical layer to the destination	CSMA/CD
Physical	• Manages data transport in the form of binary frameworks on physical media	RS232



ACTIVITY 8.2

After learning about the telecommunications software, list the important software and its roles.

8.4.5 Communication Application Software

Telecommunications applications are software applications that can run in the network to enable the transfer of data or information to other nodes or computers. Commonly used applications in telecommunication networks are:

(a) Electronic mail – enables messages or letters to be sent quickly online.

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(b) Voice mail – enables the user to store, receive and leave any messages orally from or to anyone without being limited by time or place through the telephone.

(c) EDI (electronic data interchange) – this includes the exchange of documents, software, reduces the use of paper as well as expedites the process of business application implementation and online information exchange like **electronic software distribution** that enables software to be downloaded from a computer that is located far from the client computer using a computer network. This redefines the way businesses function today.

(d) EFT (electronic fund transfer)

(e) Telecommuting and distance learning have enabled workers and students to work or study wherever they are at any time.

(f) Teleconferencing and video conferencing gather a group of people to discuss and exchange ideas without having to be present at a certain location and time.

(g) Other telecommunications applications include **the Internet**, **intranet**, **extranet**, **electronic commerce**, **Internet relay chat (IRC)**, and **bulletin board system**, all of which will be touched upon in the topics ahead.



ACTIVITY 8.3

We have discussed several applications. List the telecommunications applications that you use in daily life.

8.5 INTERNET

The internet is the short form of "international networking" that refers to the largest type of global network. It offers many services like electronic mail, file transfer and group work. Unlike other computer networks, the Internet is not managed by a governing body or certain organisation, but by many parties that work together. The largest network that joins together hundreds of thousands of networks all over the world enables organisations to perform their business with other organisations, both internally and externally. More than 35 million people worldwide use various services through the Internet. The Internet also acts as a catalyst to conduct commerce and business electronically.

The Internet is network to network, and often exchanges information by using standards and certain open protocols. It consists of more than 200,000 computer

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networks owned by governments, universities, public and private companies. It is a packet-switched network that uses TCP/IP (Transfer Control Protocol/ Internet Protocol). The user can access the Internet by using a LAN (local area network) server, through the SLIP/PPP, or any other online services (Internet service provider).

The Internet concept has brought about the **intranet** and **extranet** technologies. Do you recall what intranet and extranet are? **Intranet** is an internal network that is created for the purpose of an organisation. The number of users that can access the information from the intranet is limited because it is solely owned by that organisation. Only those in the organisation or who have permission from the organisation can access the intranet services. **Extranet** is a network that uses Internet technology for connecting clients, suppliers or other organisations to certain divisions in an organisation's **intranet**.

Through the various services offered by the Internet, an organisation enjoys the following benefits as well as opportunities:

(a) Global relations for companies or enterprises to expand and manage the international branches and business units.

(b) Reduction in communication costs and business costs.

(c) Facilitation of communication and coordination.

(d) Expeditious information dissemination.

(e) Promotion of electronic commerce and business.

(f) Interactive marketing. The Internet enables an organisation to interact directly with clients through online discussion groups, bulletin board systems, electronic questionnaires, mailing lists, electronic newsletters and electronic mail.

(g) Facilitation of the implementation of strategic collaborations between organisations and customers, suppliers, consultants, contractors or competitors.

An enterprise may fully benefit from the Internet in its organisational connections by using all the facilities offered by the Internet to connect all its web pages at the global level, while the intranet can be used to contact its subsidiary companies at other locations. The extranet can be fully realised to form relations with its other partners.

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SELF-CHECK 8.5

Elaborate on the use of the internet.



ACTIVITY 8.4

Imagine that you are the marketing manager of an organisation. How would you market your product through the internet? Identify the telecommunications applications that you need to use.

8.5.1 Internet Services

As a transport mechanism that is cheap and easy to use, the Internet provides three classes of main services that have many types of implementation:

(a) Communication – Electronic mail, USENET, newsgroup, LISTSERVs, chatting, Telnet, Internet Telephony, Internet Fax

(b) Information Access – Gopher, Archie, WAIS, FTP, Veronica

(c) World Wide Web – The web is a universal standard used to store, access, format and display information through a client / server architecture. It is easy to use because it uses a graphical user interface. It is capable of handling various types of digital data like text, hypermedia, graphics, audio and video.

Users access the web by using browsers like Netscape and Internet Explorer. Search engines are programs that list web pages (identified through URLs) that match what the user is looking for.

Today, the WWW is a very popular Internet service. It is a standard system to obtain, format as well as display information by using a client/server architecture. It can consist of a combination of texts, graphics, audio, animation and hypermedia that produces a more attractive document. The user can also host individual, group or organisational webs for the purpose of informing, advertising, promoting and others. The programming language used by WWW is the hypertext language known as Hypertext Markup Language (HTML) which enables one document to be linked to another.

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8.5.2 Internet Usage in Business

The use of the Internet in business has helped form millions of new businesses that operate at a minimal capital cost but encompass the whole world. It also helps the organisation to save cost on internal and external communication. How can this happen? It is through several forms of creative and productive Internet use. Figure 8.4 shows briefly the use of the Internet in businesses.

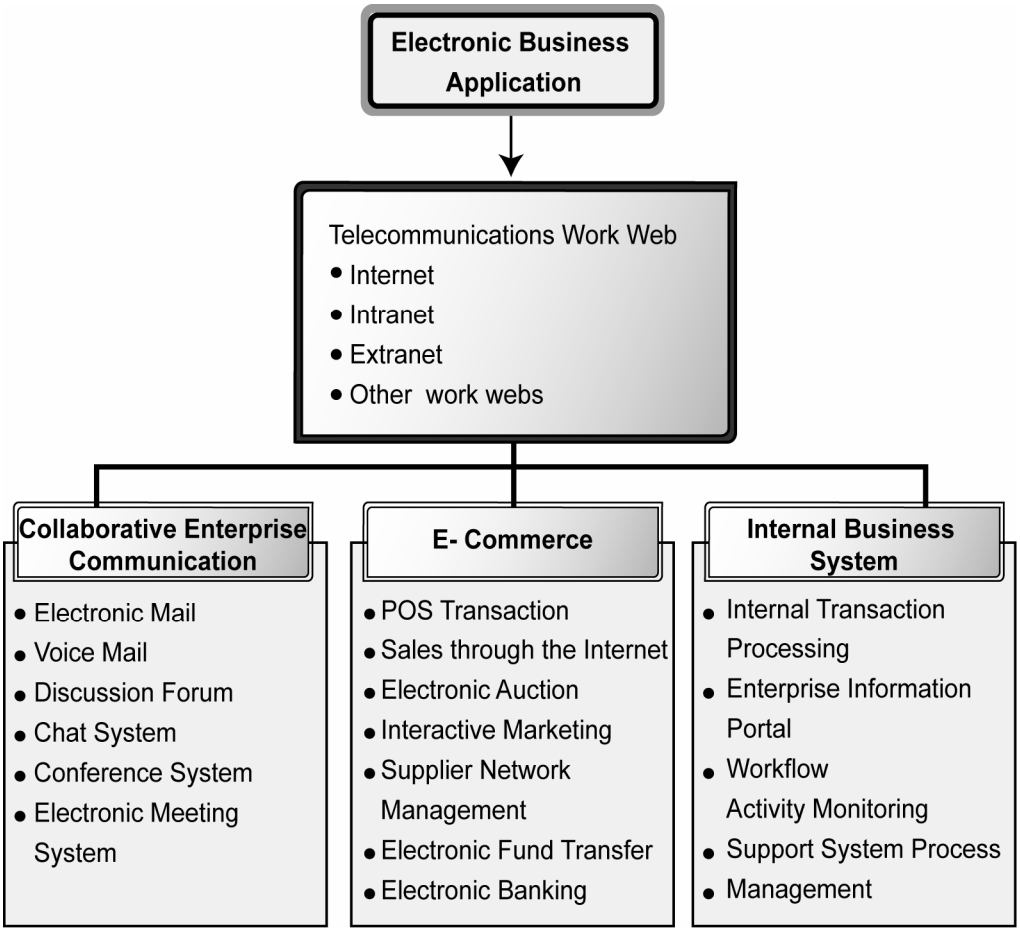


Figure 8.4: Internet usage in business

(a) **Communication and Collaboration**

Applications that support communication, coordination and corporation among members in a workgroup, business team like workers and external consultants in a project that may use the Internet, intranet and extranet to support electronic mail, video conferencing, and the like.

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(b) **Electronic Commerce**
The Internet, web pages as well as Internet based technologies like the intranet and extranet provide a global connection between companies, clients and suppliers. They encourage electronic trading activities like marketing, purchasing, selling, and support for products and services performed through this work web.

(c) **Internal Business System**
Internet-worked e-business application supports the process and operation of internal business of a company. For example, a worker may use the intranet enterprise information portal to access information about the remaining number of leave days or apply for leave. The company could also join the intranet with the Internet and this would make it easier for workers or the management to obtain information about their company wherever they may be.

(d) **Web-Based Discussion Forums**
Now, discussions among workers can be conducted through the Internet. The message that needs to be sent to all parties can be done quickly and effectively through USENET, for example. Replies can also be received instantly.

(e) **Mining Data with Intranet Search Tools**
The Internet has an efficient data searching mechanism through the use of the browser. This technology enables the user to find information by using a user friendly interface.

8.5.3 Internet Challenges

The Internet has also left several new challenges that were never a problem for the organisation in the past, but can now change an advantage into a serious disadvantage. Some of these challenges are as follows:

(a) **Implementation of business model that is not robust**. Only companies that are well established from the perspectives of infrastructure as well as meticulous planning can withstand the pressures of business.

(b) The need for planning to face **business process change**. When new technology is introduced, it will bring change in terms of work implementation and others. Therefore, management must have a complete plan to address this matter so that the implementation of the information system is successful.

(c) **Technological barriers** experienced, especially by companies that have recently started their businesses from the perspective of availability of more advanced and expensive telecommunications tools.

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(d) **Legal issues**. To date there has been no concrete laws related to electronic commerce.

(e) **Security and privacy**. The security of information channelled through the Internet cannot be guaranteed because the Internet system is frequently breached by hackers. They can monitor, obtain and store information during the transport of data through the network. The issue of privacy takes into account the extent to which the confidential information being channelled can be guaranteed not to be known by the public or fall into irresponsible hands.

SUMMARY

- This topic explains the telecommunications network and its components, which are the hardware, software and individuals that form the support for this network. The implementation of certain information systems requires the appropriate supporting telecommunications infrastructure.

- Whether it is LAN or MAN, the communication networks of an organisation could be formed as a star, ring or bus, or a combination of these topologies. Management should understand the difference among the technologies of telecommunication systems components (in terms of data rate, price, strengths and weaknesses) that form these network topologies in order to decide better for the planning of an appropriate information system architecture platform. Only then the organisation could fully utilise the advantage of the telecommunication technologies to bridge all branches and business units efficiently.

- Every opportunity comes with a challenge, and so does Internet technology. Internet usage in business enables management to plan for wider coverage by implementing intranet, extranet and many other collaborative communication systems. Nevertheless, there is a need to understand the changes in business processes, the need to implement a new business model to withstand the changing technology, the technology barriers, legal issues, and security and privacy of the organisational information.

KEY TERMS

Local area network	Telecommunications system
Metropolitan area network	Value added network
Network	Wide area network

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Topic 9 ▶ Functional Information Systems and Decision Support Systems

LEARNING OUTCOMES

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

1. Explain the characteristics relating to the functional information system;
2. Describe the general categories about the functional information system;
3. Integrate the correct functional information system for daily use by the organisation;
4. Assess the decision making levels;
5. Differentiate between a decision support system and the related systems; and
6. Examine the use of artificial intelligence in our daily lives.

▶ INTRODUCTION

In the beginning, functional information systems were developed specially for carrying out specific functions such as a system for the accounts, marketing and finance departments. These systems were not related to one another. Thus, information management was not effective in some cases that required a solution from several system functions.

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Consequently, an integration of these systems was developed. For example, this new system combined the functions for accounts, marketing and finance together into one system. This was aimed at increasing an organisation's productivity, quality and customer services.

In this topic, we will provide a comprehensive list of the types of information systems and will focus on several system functions individually.

9.1 FUNCTIONAL INFORMATION SYSTEMS

Before looking at the different types of information systems, we need to learn about the information systems based on their general characteristics (for all types of information systems). Information systems that perform specific functions are called functional information systems (integrated information systems that carry out many functions in a single system). Now, we are ready to be introduced to the different types of information systems as per shown in Table 9.1.

Table 9.1: Characteristics of Functional Information Systems

No.	Characteristics of Functional Information System	Example
1.	It consists of several sub-systems of an information system that support specific functions or activities.	An attendance system can store and trace the attendance records and working hours of workers.
2.	Even though this system focuses on certain activities, it can be integrated with other functional information systems to form a single system that is useful for the organisation.	An accounting information system can be integrated with the marketing information system to facilitate transactions and the tasks between those two departments.
3.	Functional information systems can interface with others to form a complete information system for the organisation. This is the result of the integration of the sub-systems.	Attendance records, overtime claim records and salary records from different sub-systems can be integrated to calculate the amount to be paid to employee for the previous month.
4.	This information system can also interface with the surroundings.	The marketing information system can obtain feedback from the user or the client through online feedback facilities (like feedback forms in websites).

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9.2 TYPES OF INFORMATION SYSTEMS

The types of information systems rely heavily on the management hierarchy in the organisation. This is because different information systems are developed to support the different management functions within the organisation. For this, we need to understand the management structure within the organisation and relate it to the different types of information systems.

9.2.1 Levels of Management in the Organisation

Through the illustration of the various types of structures discussed in Topic 2, we can observe that there are several levels of management in any chosen structure. In general this management level can be divided into three levels (refer to Table 9.2).

Table 9.2: Three Levels of Management in the Organisation

Three Levels of Management in the Organisation
• Lower level management or operations management. • Middle level management or tactical management. • Higher level management or strategic management.

These levels can be categorised according to the authority or responsibility of each individual who is involved. In other words, the levels are closely related to the process of decision making. The different levels make different decisions.

In order to understand this division, we will discuss the concept of decision making in management. Then, we will use the pyramid model of decision making in the organisation as the basic reference, as shown in Figure 9.1.

9.2.2 Management and Decision Making

In general, management means the use of resources to achieve goals effectively and efficiently. In an organisation, management is normally performed by a manager. What do you think is the role of the manager? It can be divided into three main categories (refer to Table 9.3).

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Table 9.3: Role of the Manager

Managerial Role	Description
Interpersonal role	• The manager is seen as the leader and mediator of the workers. • The manager is the role model for the workers.
Informational role	• The manager monitors the activities and work done by the workers and organisation, distributes the tasks and resources, as well as is the spokesperson for the workers with external parties. • For example, the manager will provide feedback from the upper management or customers regarding the customer friendly service that is provided by the workers.
Decision making role	• The manager puts in a lot of effort, handles problems, distributes resources, as well as holds negotiations for the workers and external parties.



ACTIVITY 9.1

In your opinion, what is good decision making?

Decision making is the process of making a decision that is accurate and clear in solving a problem or doing something new. In brief, decision making begins from the analysis of the problem or opportunity and then deciding what should be done to solve the problem or grab the opportunity. It also includes the strategic planning of the organisation in achieving its vision and objectives.

Strategic planning ensures that the long-term objectives are met by analysing the strengths and weaknesses of the organisation, forecasting future trends and predicting new product or service development.

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In analysing the problem or opportunity, the information used can consist of:

(a) **Internal information**

(i) Obtained from within the organisation itself.

(ii) For example, information on the attendance of workers or their personal details.

(iii) Stored in the departmental or organisational database.

(b) **External information**

(i) Obtained from outside the organisation.

(ii) For example, from the Internet, government reports or newspapers.

Figure 9.1 shows the pyramid structure for decision making for each of the three levels of management:

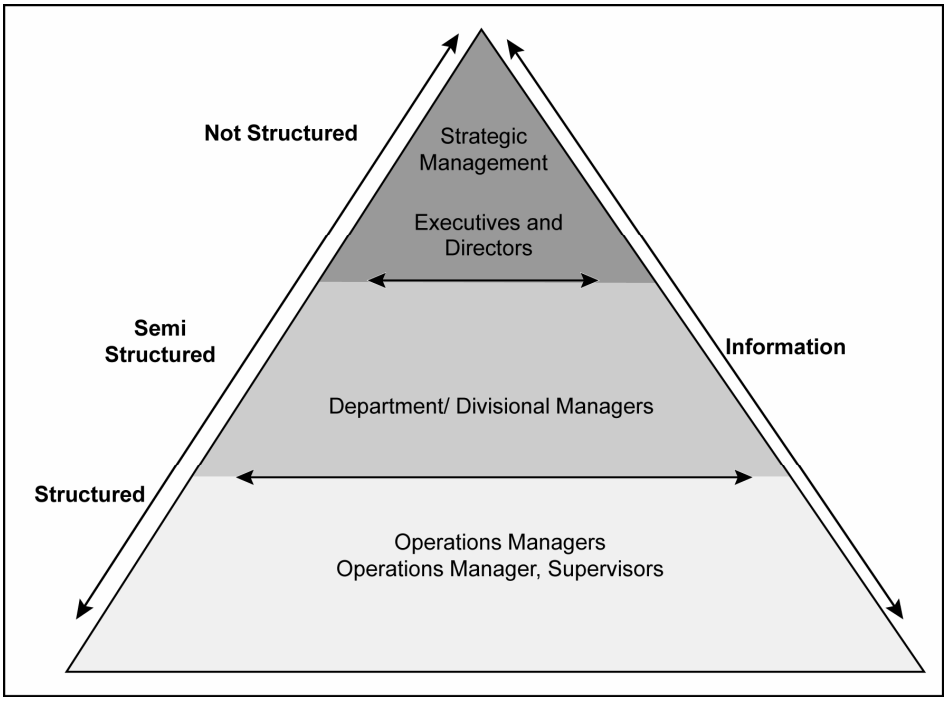


Figure 9.1: Decision making structure adapted from O'Brien (2004)

(a) **Unstructured Decisions**

(i) Made at the strategic management level.

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(ii) This level makes strategic decisions like the direction of the organisation, performance, investment choices and strategic development. To assist strategic management in the process of making these decisions, the information required is in many forms like brief information reports, ad-hoc reports, non-periodical reports, forecasts as well as external information that can help in their planning.

(iii) Examples of information that are needed include profit/loss reports for the whole organisation, profit/loss report of every department, market predictions, available capital, and total cash needed.

(b) **Semi-structured Decisions**

(i) Made at the tactical management level like the head of department or divisional manager.

(ii) Has a guide for reference in order to obtain a more detailed decision consistent with its authority that is less than the strategic management level.

(iii) The managers are responsible for making short-term and mid-term plans for the organisation. Some of the tasks of the managers are:

- Scheduling or distribution of tasks.
- Formulation of the budget.
- Giving explanation of the policies, procedures and objectives of the organisation to the sub-units under their control.
- Distribution of the resources and control of the execution of tasks by each sub-unit in the organisation.

(iv) The types of problems that need to be addressed by the managers are simpler than strategic management but much more complex than the operations division.

(v) Information is necessary from the upper management and operations management. This is because the tactical manager has to ensure that all plans by the strategic management can be implemented by the operations management.

(vi) Examples of information included in mid-level management are productivity measurement, budget control, gap analysis, cash flow prediction, profit decision, short-term purchase and worker transfer.

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(c) **Structured Decisions**

(i) A detailed and clear guideline has been set to form the procedures that can be followed to obtain accurate answers.

(ii) This is carried out at the operations management level which is directly involved in performing and controlling the daily operations of the organisation, like supervising and managing operations.

(iii) All distributed and scheduled tasks must be successfully performed.

(iv) The common problems encountered are structured problems that can be solved based on specific procedures, like resolving the problem of workers always coming late to the office.

(v) Examples of information used by managers at the operations level are the information related to the processing of wages, detailed information about the daily transactions and information on the process of producing a product.



ACTIVITY 9.2

Which is more important, using the information system for operations or management functions?

Why do managers need information technology support? Even though it is not impossible to make decisions without information technology, its use facilitates the process because:

(a) Information technology provides many alternatives in obtaining information from new communication technology like the Internet and electronic commerce.

(b) Information technology reduces the pressure of deadlines because it expedites processing.

(c) It reduces the complexity of decision making because information technology facilitates and expedites the process of analysis of information.

(d) Information technology can help fulfil the need to access information and expertise from a long distance. For example, through the use of the Internet, you can access information from a university in Australia or even contact a specialist doctor in China through video conferencing.

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9.2.3 Information System Support for Various Levels of Management in the Organisation

Based on the role played by each manager as well as the type of information he needs, several types of information systems to help decision making have been developed and adapted for each level. Table 9.4 shows the types of management and the forms of information system appropriate for their functions.

Table 9.4: Information System Categories

Level of Management	Category	Example
Strategic Management	Strategic Management System	• SIS – Strategic Information System • EIS – Executive Information (Support) System
Mid-Level Management	Tactical Management Support System	• MIS – Management Information System • DSS – Decision Support System • OAS – Office Automation System
Operations Management	Operations Support System	• TPS – Transaction Processing System • PCS – Process Control System • ECS – Enterprise Collaboration System
All three levels of management	Other types	• ES – Expert System • KMS – Knowledge Management System • FIS – Functional Business System



ACTIVITY 9.3

Visit the Amazon online bookstore (www.amazon.com). Observe the services provided. What is your opinion of this website? What system category would it be placed under?

(a) **Information System for Operations Support**

This information system types of information processes the data produced or used in business operations. It processes various for internal and external use by the organisation. However, it does not provide specific information that is normally required by the tactical management or upper management. The process should be performed subsequently by the MIS

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on the output produced. The roles of the support system level on operations include:

- Processing business operations effectively.
- Controlling industrial processes.
- Aiding communication and collaboration.
- Updating the corporate database.

Examples of the information systems that are involved are Transaction Processing System and Process Control System.

(b) **Information System for Supporting Tactical Management and Strategic Management**

Information system for tactical management assists in the decision-making functions normally used by middle management. This system plays the role of accessing, arranging, producing summaries and displaying the information to assist in the decision-making process. It collects data on daily or weekly sales, company profit and others, and then it processes the data to produce a report and report summary for use by mid-level managers to plan the company's subsequent steps.

It gives focus to the preparation of information and the support for managers to make effective decisions. It assists in decision making at the highest level of management, middle (tactical) and also at the operations levels.

The availability of information and support for the decision-making process at various levels of management is a complex procedure. Conceptually, there are several types of main information systems that are needed to help the management tasks, especially at the upper level.

Some of the examples are as follows:

(i) Office Automation System (OAS)

- Assists in office tasks and operations.
- May consist of word processing functions, design (that may require the use of CAD/CAM software) to the use of robotics.

(ii) Decision Support System (DSS)

- Used by senior executives to assist them in their work.

(iii) Executive Information (Support) System (EIS)

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- Prepares the latest information quickly for strategic management, especially information related to the **critical success factors (CSFs)** that need to be identified in order to achieve the set objectives.

(iv) Strategic Information System (SIS)

- Produces products, services as well as the capability to use information technology to gain a competitive edge when faced with the organisation's rivals in the global market arena. This has produced a strategic information system that supports or directs positions in a competitive environment.

(c) **Management Information System**

MIS can directly aid management operations and activities. This system can consist of Production Information System, Manufacturing Information System, Accounting Information System, Financial Information System, Human Resource Information System, and Marketing Information System.

(d) **System Based on Artificial Intelligence**

Management information systems today frequently involve unstructured decision making processes. Normally in these situations, the techniques used in the field of artificial intelligence may help.

Many information systems today are equipped with artificial intelligence, like:

- Expert system, for example to diagnose a disease.
- A system based on knowledge that is developed to manage learning in an organisation. It helps the upper level of workers to build, arrange and share business knowledge at any time, place and situation as required.



ACTIVITY 9.4

Visit the Carnegie Mellon University (www.cs.cmu.edu) and MIT (www.ai.mit.edu) websites for the latest development in manufacturing.

Visit www.brint.com for exposure on knowledge management.

(e) **Integrated Information System**

A united information system is a computer-based system that joins together the capabilities of several types of functional information systems into a single system.

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SELF-CHECK 9.1

List five information systems and briefly describe their respective roles.

9.3 TRANSACTION PROCESSING SYSTEM (TPS)

Every organisation performs business transactions daily. Basically, a business transaction occurs each time the organisation produces a product or service for its customers. It also includes the daily management and main management activities performed by the organisation.

Some of the examples are:

- A business transaction for a university or a college is teaching and evaluating students.
- Managing the booking and sale of tickets to customers in an airline system.
- Managing the ticket sale and the light rail transit (LRT) ticketing system.

In order to perform these transactions more effectively and efficiently, the transaction processing system (TPS) is introduced. Its main function is to collect all information relating to the business transactions and to process it to produce a relevant output.

9.3.1 TPS Objectives

The main objective of the TPS is to prepare the required information so that the organisational operations can be implemented effectively and accurately. Its other objectives include:

- Enabling the organisation to operate efficiently and effectively.
- Preparing reports and documents right on time.
- Increasing the competitive advantage of the organisation.
- Preparing accurate data for the strategic and tactical systems, for example data for the management information system (MIS) and decision support system (DSS).
- Ensuring the accuracy and reliability of the data and information.
- Controlling the security of the data and information.
- Helping maintain loyalty of the user/customer.

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9.3.2 TPS Methods/Processes

There are three general methods for TPS, which are:

(a) **Batch Processing**
All transactions are collected into a batch for a certain period of time before processing. This gives time for the updating of the records in a transaction.

The system gathers all the departmental transactions into several batches, prepares them for processing and then processes at the end of each operation day.

Example: a wage system collects all the information related to attendance and the number of working hours each day within a working month. While waiting for the end of the month to process the data, the information may still be updated if required. When the set time arrives (example: end of the month), the system calculates the total working hours and the wage that each worker should receive.

(b) **Online Transaction Processing (OLTP)**
The OLTP is also known as real-time processing.

The transaction is processed as soon as it occurs.

Examples: the cash withdrawal system in banks – when a customer withdraws money from his account, the system immediately updates the account. When you book a plane ticket, the system updates the database which contains information on the seating arrangements, payment total, and others. You instantly get your booking status. This online transaction processing gives the latest status of each transaction.

(c) **Hybrid System (Online Entry with Delayed Processing)**
This process or method is a combination of both the earlier methods. The information or data from the transaction is taken and entered into the computer, but it will not be processed automatically.

Example: when you make a booking through a tax free channel, your booking will be taken and entered into a computer. Even though the booking has been entered into the computer, it may only be processed after office hours or the following day.

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ACTIVITY 9.5

To test your understanding, state other examples of the three processing methods mentioned above.

9.3.3 TPS Activities

Now, let us look at six main tasks in the transaction processing activity cycle. This is illustrated in Figure 9.2.

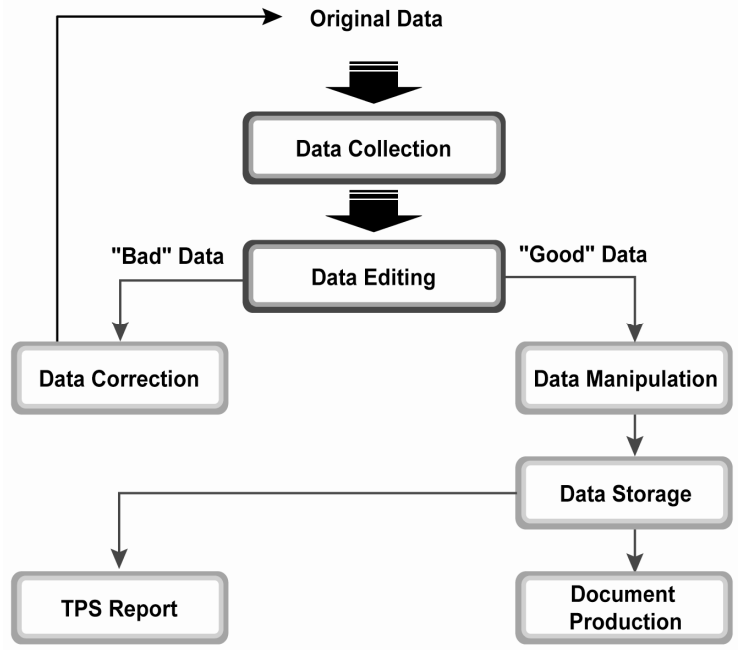


Figure 9.2: General data processing activities in TPS.
Source: Adapted from Stair R., & Reynolds G. (2005). Principles of information systems (7th ed.). Thompson

(a) **Data Collection**

(i) The process of obtaining and collecting the data required for a complete transaction.

(ii) Exists in two forms, which are:

- Manual, like collecting product orders in writing

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- Automatic, like obtaining data from a terminal scanner or input peripheral

(iii) The method of entering data can be implemented in various ways, such as:

- Using the keyboard.
- Source data automation – it is faster and its accuracy is guaranteed because the data collected will be scanned straight into the system from its source. Example: scanning using a bar code reader in a supermarket.

(b) **Data Editing**

(i) The process of checking data to ensure data integrity and the completeness of data.

(ii) Example: a worker's name must be in the form of letters and his staff number in numerical form, otherwise the data is invalid and incorrect.

(c) **Data Validation**

(i) The process of re-entering data found to be incorrectly typed in the process of editing the data.

(ii) The TPS should produce a reminder message if there are any errors to the data being entered.

(iii) Example: an error message is produced if you accidentally entered a number when keying in the worker's name.

(d) **Data Manipulation**

(i) The process of carrying out calculation and data transformation which are related to the business transaction.

(ii) This includes the classifying of data into certain categories, performing calculation and storing data in a database for the next process.

(iii) Examples:

- The calculation of a student's average marks in a semester will take into account the total marks attained by the student, which are divided by the total credit hours taken.
- A wage system that multiplies the number of working hours with the wage per hour of each worker.

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(e) **Data Storage**

(i) The process of updating one or more databases with a new transaction.

(ii) After the database is updated, other systems can obtain and use the data for other processes.

(iii) Exists in two forms, which are:

- Manual, like collecting product orders in writing.
- Automatic, like obtaining data from a technical scanner.

(f) **Production of Reports and Documents**

(i) The process of producing output records and reports whether in soft copy form or hard copy form.

(ii) Example: obtaining your examination results document in hard copy form, which is the examination result transcript that is printed, or in soft copy that is displayed on the computer screen.



ACTIVITY 9.6

After learning about the characteristics and activities of the TPS in general, can you think of examples of the TPS that are usually performed?

9.3.4 Traditional Transaction Processing System Applications

There are three main applications for a traditional transaction processing system, which are:

(a) **Order Processing System**
Some of the processes in this system are:

(i) **Entry of Orders**
- Obtaining the basic data required for customer order processing.

(ii) **Sales Configuration**

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- Ensuring that the products and services ordered are sufficient to fulfil customer objectives and that everything runs smoothly.
- Example: with this sales configuration, the printer salesperson will know that the computer printer needs a certain cable together with a LAN (local area network) card in order to enable it to be connected to the LAN.

(iii) **Logistical Planning**
- Planning what has to be sent where in accordance with the orders.

(iv) **Logistical Implementation**
- Coordinating the product outflow from the organisation with the objective of delivering quality products on time to the customers.

(v) **Inventory Control**
- Updating using a computerised inventory record system related to displaying the correct quantity for each share held.

(vi) **Customer Interaction**
- Monitoring and tracking each customer transaction with the company.

(vii) **Scheduling**
- Determining the best time and method of delivering the products and services so that they arrive on time and in good condition.
- Example: for sending fresh vegetables from the farms to the city centre, a system determines whether transport by train or lorry will ensure that the vegetables arrive fresh at their destination.

(b) **Purchasing System**

A purchase transaction processing system has four processes:

(i) **Inventory**
- Operating like the inventory system discussed previously.

(ii) **Purchase Order Processing**
- Helping the purchasing department to complete the purchase transaction more efficiently and effectively.

(iii) **Receiving**
- Making a record of the receipt of the goods delivered.
- The goods delivered are checked by the buyer to determine their quality and if they are in bad condition, they will be returned to the supplier.

(iv) **Receivable Account**

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- Increasing organisational control over purchasing, improving cash flow, increasing profit and providing more efficient management in the face of current liabilities.

(c) **Accounting System**

Some of the processes in an accounting system are:

(i) **Budget Transaction Processing**
- Automating many tasks necessary for collecting budget related data, distributing it to the user, and consolidating the budget.

(ii) **Non-Receivable Account**
- Managing the organisational cash flow by tracking amounts owed by the buyers or service users.
- Important for identifying debtors as well as ensuring that each debt is settled.

(iii) **Salary**
- Relating to the salary payment transaction beginning with the calculation until the production of a report in the form of a payslip.

(iv) **Asset Management**
- Controlling the investment in capital tools and managing the depreciation to maximise the tax benefits.

(v) **General Ledger**
- Automating financial reporting and data entry.

A summary of main applications for traditional transacsion processing system are shown in Table 9.5.

Table 9.5: Some Sub-systems that Support the Order Processing System, Purchasing System and Accounting System

Order Processing System	Purchasing System	Accounting System
• Order Entry System • Sales Configuration System • Logistical Planning System • Logistical Implementation System • Inventory Control System	• Inventory System • Purchase Order Processing System • Receiving System • Receivable Accounts System	• Budget Transaction Processing System • Non-Receivable Accounts System • Salary System • Asset Management System • General Ledger System

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• Customer Interaction System • Scheduling System		

ACTIVITY 9.7

Let us assume that you grow flowers commercially in Cameron Highlands. Your customers are located all over Malaysia. Which functional sub-system will you choose to ensure that the flowers are delivered fresh to your customers? Elaborate on the reasons for your choice.

SELF-CHECK 9.2

What are the objectives of the Transaction Processing System?

9.4 OTHER FUNCTIONAL INFORMATION SYSTEMS

9.4.1 Marketing Information Systems

Marketing information systems are related to the planning, promotion and sale of products in the current market, new product development as well as new markets to cater for current and potential customers.

In order to satisfy the customer, the marketing organisation must use several channels. A **distribution channel** is used to prepare the goods and services for the customers and wholesalers. The channel chosen depends on each marketing process. An example of a short channel is direct purchase from the factory, whereas a long channel would be a product that is transported from the factory to the wholesaler, and then to the supplier, until it reaches the buyer.

There are several other channel systems that support the various marketing activities, for example, the after sales support system. This channel system can play a role in the marketing system, sales system, supply system, and others. Changes in one channel will affect another channel. Therefore, this channel must be integrated to avoid encountering any problems. In this topic, we will look at several channel activities that have been classified into four groups.

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(a) **Customer Services**

Today, customer services play an increasingly important role in the organisation to ensure that each product and service sold satisfies customer needs. This would ensure user loyalty towards the product or the organisation.

Through customer service, the organisation can identify and know more about its customers and their needs. Now, there are various ways to implement customer services. They include the use of a website and a computerised user assistance system.



ACTIVITY 9.8

Can you give an example of a customer service that you have used? Were you satisfied with the service?

(b) **Telemarketing**

Telemarketing is the process of using telecommunications technology and information technology to market the products and services to consumers who want to make purchases from the comfort of their homes. Consumers can use telemarketing to buy goods through the television or through the computer and the Internet. For example, ordering goods from Quantum Gallery or from the amazon.com website.

(c) **Channel Distribution Management**

Channel distribution management is important for ensuring that the goods ordered are delivered to the user in an appropriate and safe way, as well as on time. For example, an organisation has to determine whether to send the ordered goods through express post or normal post.

(d) **Marketing Management**

In general, marketing management aims to ensure that the demand for a product or service of an organisation can be fulfilled effectively and efficiently.



ACTIVITY 9.9

Can you give an example of a customer service that you have used? Were you satisfied with the service?

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9.4.2 Production/Operations Management

In general, the manufacturing information system or production/operations management is responsible for the process of changing input into output. It also supports the planning and control of purchases, production and distribution of goods and services.

This system is commonly used in the manufacturing industry and often with other systems like Computer Aided Design (CAD), Computer Aided Manufacturing (CAM) or Computer-Integrated Manufacturing (CIM). CAM uses a computer-assisted process to plan and control the manufacturing facilities.

9.4.3 Human Resource Information Systems

As we are aware, human resource management is an important task in an organisation. It involves the recruitment, placing, evaluation, compensation payment, and staff development of an organisation.

In this topic, we will look at three important groups of tasks of human resource management.

(a) **Staff Recruitment**
This process begins by searching for candidates, testing them and deciding who succeeds. Information technology can help in this process:

(i) **Position Inventory**
The organisation prepares a file related to the vacant positions that are available, together with other information such as job position, qualifications required, current availability and location of position. This file or record is kept in a database and it is continually updated as well as monitored by the management.

This inventory will produce a list of vacant positions from time to time and match the vacancies with certain candidates. If this system is connected to the Internet, the list of vacancies can be viewed by interested candidates no matter where they are located.

(ii) **Recruitment through the Internet**
Many organisations advertise vacant job positions through the Internet. Employment agencies too use the Internet in their business.

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For example, you can visit the jobstreet.com website to scrutinise the way jobs are applied for through the Internet and the vacancies being offered.

(iii) **Employee Selection**
The human resource department can search, test and select employees through the two methods above.



ACTIVITY 9.10

Visit http://www.jobstreet.com. What can you observe about the services offered?

(b) **Human Resource Development**
The management of the organisation is responsible for training and evaluating the performance of the selected employees. The computerised training that can be given is a training programme based on a computer and multimedia.

Some examples of the training given are:

- An airline pilot is taught and trained to handle an aeroplane by using a flight simulation system.
- New employees can use the tutorial system to learn to handle the system used in the organisation.

(c) **Human Resource Planning**
What planning can be performed by the human resource department? Human resource management has files containing employee information from personal details to the work performance of each employee. From these records, the management can monitor and plan activities as well as training for employees. For example, they enable the management to analyse performance and then plan reasonable benefits.

A clear picture about the examples of functional information systems can be seen in Figure 9.3.

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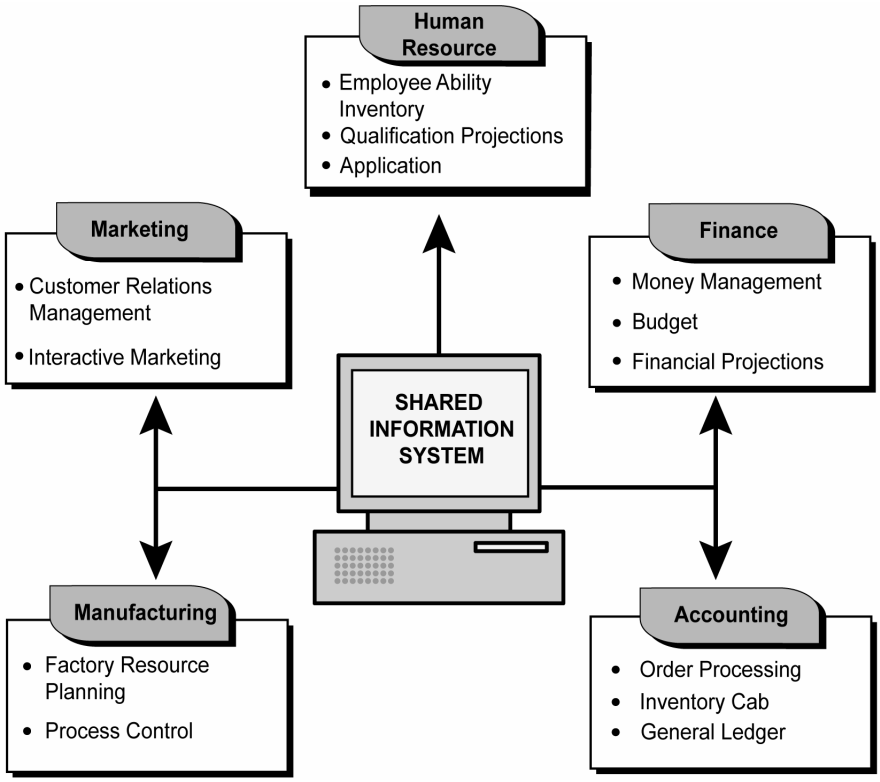


Figure 9.3: Functional information systems

9.5 MANAGEMENT INFORMATION SYSTEMS (MIS)

A management information system (MIS) is the original information system that has been long developed with the aim of supplying information to assist the manager in carrying out various daily activities. This is so that the process of planning, control and monitoring can be implemented more efficiently and effectively.

In general, MIS consists of several collections of sub-systems that focus on certain functions or tasks, like Accounting MIS, Marketing MIS and Manufacturing MIS. For example, Finance MIS consists of several sub-systems relating to financial reports, profit and loss analysis, cost and usage analysis, and fund management.

The input for MIS is information produced from internal data, which is obtained from the results of the Transaction Processing System (TPS); and external data as discussed previously.

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The output is a collection of reports that are distributed to the managers. These reports are divided into three main categories, which are:

(a) **Periodical Report**
- Produced after a certain amount of time or according to a schedule, such as daily, weekly or monthly.
- Example: Monthly departmental report.

(b) **Requested Reports**
- Produced when requested by the superiors or customers.
- Example: Reports that are requested by the departmental manager about the number of working hours by a certain employee in that week.

(c) **Unexpected Reports**
- Produced automatically when an unexpected event occurs that rarely or has never happened, which requires the action of the management.



ACTIVITY 9.11

After we have seen several functions and examples of MIS, can you think of the characteristics of MIS?

Now, let us review whether your guess is correct or not.

9.5.1 Characteristics of MIS

Below are the characteristic of MIS:

(a) Prepares reports using a permanent and uniform format. For example, a periodical financial report will have the same fields and types of data at the same locations for every report.

(b) Prepares reports in soft copy or hard copy forms. The report can be printed on paper (hard copy) or it can be read directly from the computer screen. Whatever the format, the report remains the same.

(c) Uses internal and external data. Most MIS applications use internal data from the organisational database, though external data is also used.

(d) Usually, the input for MIS is the result of the TPS.

(e) Enables the end user to produce report that he requires. It may need the production of certain programs with the help of a programmer.

(f) Able to prepare information for the use of strategic and tactical managers.

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9.6 DECISION SUPPORT SYSTEMS (DSS)

This system is an organised collection that consists of people, procedures, software, databases and peripherals which are used to support decision making and problem solving.

It also makes available information interactively to assist the manager to make decisions. The DSS alleviates the manager's burden to address business problems that are characteristically semi-structured and not structured at all.

However, this system can also be used at the operational level. It enables the management and the tactical and strategic levels to use certain models (statistical, simulation and others) as well as tools (spreadsheets, graphics and others) to analyse data obtained from outside as well as inside the organisation.

9.6.1 Characteristics of Decision Support Systems

Decision support systems have many important characteristics that ensure their effectiveness, like:

- Supporting a large amount of data from many sources. For example, data acquisition from several databases and data warehouses at different locations.
- Assigning flexibility to reports and presentations, whether the reports are produced in soft copy or hard copy.
- Offering results in the form of text or graphics. A combination of both text and graphics can increase the understanding of the management and increase the effectiveness of presentation.
- Supporting the decision-making process at the strategic and tactical management levels.
- Supporting each phase of decision making.
- Helping to solve semi-structured and non-structured problems.
- Using the modelling approach (like: statistical, financial, graphical and project management models).
- Producing ad-hoc reports.
- This system is easy to use because of its interactive capabilities and user friendliness.
- Can be used in various situations of decision making.
- Implementing simulations, goal-seeking analysis, as well as what-if analysis.
- Easily implementing "sensitivity" analysis.

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9.6.2 Analysis Models for DSS

The use of the DSS involves four types of analysis modelling activities, which are:

(a) Sensitivity Analysis
   (i) Research performed on the effects of change at one or more parts of the model in relation to other models.
   (ii) Slight change in the requisites will result in differences in achieving a solution.
   (iii) What-if and goal-seeking analyses are examples of the more popular sensitivity analysis.

(b) What-if Analysis
   (i) Requires a null hypothesis about the data for each case that has no assurance.
   (ii) It is an attempt to examine the effect of change on the hypothesis (input data) related to the proposed solution.
   (iii) The analysis process requires the user to perform several test runs with the hypothesis using various data to observe the different output possibilities.
   (iv) Examples:
      - In order to find out the quantity to be added to the stock, the manager may add several total sales values that have been sold in the related week or month. This makes it easier for him to decide on the total stock to be ordered to avoid any deficiencies or surplus in goods.
      - What happens to the student average mark if the passing mark is increased by ten percent from the original mark.
      - What happens to the car sales if the price of the car is increased by five percent from the original price.

(c) Goal-seeking Analysis
   (i) Uses the backward approach.
   (ii) Different from the two analyses above.
   (iii) Several attempts are made to find the input value that produces certain outputs.
   (iv) Focuses on the desired output. After determining the output that needs to be produced, only then can the attempt on the data with the input be performed.

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(v) Data testing is repeated until the desired output is produced.

(vi) Example: a college has decided to collect student enrolment fees totalling RM500,000.00. So, the management calculates the number of students that needs to be enrolled in order to achieve this goal.

(d) Optimisation Analysis

(i) Quite complex and originates from the goal-seeking analysis, but different from the goal-seeking analysis where there are various confirmed outputs. Finally, from these confirmations, only the most optimal output will be chosen.

9.6.3 DSS Components

The users, such as managers and decision-makers, are considered part of the system. The contributions of DSS are derived from the extensive interaction between the computer and the decision maker. Other than this human factor, the DSS has four main components, which are:

(a) Data Management

Contains a database that is managed by a database management system (DBMS) for storing data and information related to decision making. All data that flow from several sources are usually extracted prior to their entry into a DSS database or a data warehouse. In some DSS, there is no separate database, and data are entered into the DSS model as needed, such as data collected by sensors.

(b) User Interaction

Enables the user to communicate, interact and give instructions to the DSS. It is considered the most important DSS component because much of the power, flexibility and ease of use of the DSS are derived from this. Good interface can encourage users, such as managers and salespeople, to use the system. Most interfaces today are Web-based and some are supplemented by voice.

(c) Model Management

Contains software for managing the DSS model like financial, statistical and managerial science software that provides the analytical capabilities for this management process.

(d) Knowledge Management

Knowledge-based system, such as expert system, is included in certain DSS only. It can support other sub-systems and make available the knowledge to provide a solution to a problem, or to enhance the operation of the other DSS components. This knowledge component consists of one or more

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expert systems, or it draws expertise from the organisational knowledge base.

9.6.4 DSS Capabilities

DSS developers try to make the system more flexible than MIS. As we are aware, the DSS can be used at every level of decision making. Now let us look at several DSS capabilities. However, not all the following are provided by an actual DSS application.

- Supports decision-making phases.
- Supports different decision-making frequencies.
- Supports different structured problems.
- Supports different levels of decision making.
- Supports decision making over time to deal with changing conditions.
- Supports dissemination for use over the Web.



ACTIVITY 9.12

Can you think of a situation that requires you to use the DSS?



SELF-CHECK 9.3

1. What are the uses of a management information system (MIS)?
2. Describe three main report categories produced by MIS.
3. Discuss three MIS characteristics.

9.7 EXECUTIVE INFORMATION (SUPPORT) SYSTEMS (EIS)

This system is also known as an Executive Support System (ESS) that presents structured information about the organisation which is deemed important by the executives.

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9.7.1 Characteristics of EIS

Some of the important characteristics of the EIS are:

(a) Usually it is specifically for executives – the goal of the EIS is to give accurate information to individuals at the correct time and in the correct format.

(b) Easy to use because most users are decision makers who are usually not proficient in technical matters.

(c) Supports the need for external data because most of the information needed at the upper level is from outside sources.

(d) Assists in highly unpredictable situations by giving useful information and suggestions for making critical decisions.

(e) Has a future-time orientation because the decision made is for the long term and can be used in the next few years.

(f) It is connected to the process of value added business which is then connected to the DSS to increase the effectiveness and capabilities of the system to make better decisions.

9.7.2 EIS Capabilities

Some of the capabilities of the EIS are:

(a) Supports strategic management because the EIS enables decision making for the long term.

(b) Supports the formation of an overall organisational vision with the strategic planning that is made.

(c) Supports strategic management and staff recruitment.

(d) Supports strategic control in monitoring and managing organisational operations.

(e) Supports crisis management especially planning in the event of an accident, fire and the like, which can halt organisational operations. The EIS can help executives to plan for these disasters.

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9.8 ARTIFICIAL INTELLIGENCE (AI)

9.8.1 Background of Artificial Intelligence

In brief, AI is a computer system that has the ability to think and act like humans. It is not developed to take over their job to think and act on the whole, but to help alleviate the workload shouldered by them.

Artificial intelligence is defined as a science and technology whose goals are to produce a computer that can think, see, hear, talk, walk and feel.

9.8.2 Objectives of AI

The three main objectives of AI are:

(a) To make the machine smarter, that is, in making its own decisions without waiting for human instructions.

(b) To understand what intelligence is and to exploit it in our daily lives.

(c) To make the machine more useful because it can make its own decisions and learn from experience.

All of these objectives can be achieved by imitating human behaviour and intelligence.



ACTIVITY 9.13

What behaviour is considered intelligent? Can you identify several signs of intelligence?

9.8.3 Characteristics of Artificial Intelligence

Some of the characteristics of artificial intelligence are:

(a) Storing information from experience into a knowledge base, learning, understanding and using it in the future.

(b) Giving meaning to messages that are varied and complex.

(c) Give a quick and correct response to a new situation based on its knowledge and experience.

(d) Preparing and using reasoning to solve problems.

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(e) Overcoming complex situations that require a lot of information sources or a quick solution.



ACTIVITY 9.14

Based on the above characteristics of artificial intelligence, can you differentiate between artificial intelligence and human intelligence?

9.8.4 Capabilities of Artificial Intelligence

In order to understand the capabilities of artificial intelligence, let us look at the differences between artificial intelligence and natural intelligence, as summarised in Table 9.6.

Table 9.6: Comparison between the Capabilities of Artificial Intelligence and Natural Intelligence

Attribute	Natural Intelligence (Human)	Artificial Intelligence (Machine)
Ability to sense (sights, hearing, touch, smell)	High	Low
Ability to be creative and imaginative	High	Low
Ability to learn from experience	High	Low
Ability to adapt	High	Low
Ability to develop intelligence	High	Low
Ability to use various information sources	High	High
Ability to collect a lot of external information	High	High
Ability to perform complex calculations	Low	High
Ability to transfer information	Low	High
Ability to perform a series of calculations quickly and accurately	Low	High

Source: Adopted from Stair, R. & Reynolds, G. (2005). Principles of information system (7th ed.). Boston, MA: Thomson Course Technology.

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9.8.5 Trends in Business Information System Applications

The trend of business information system applications is moving towards application integration and the use of artificial intelligence. Some of the uses of these types of applications are as follows:

(a) Facilitate the transaction process
- Example: with the integration of the accounting information and human resource information systems, the calculation of wages and compensation can be carried out quickly and easily.

(b) Used with network and Internet technology, especially in the process of obtaining external sources or information.
- Example: in strategic planning, the organisation can obtain information about its competitors that is on the Internet. The organisation can also look at the reports and government mission.

(c) Allow the use of multimedia elements like text, graphics, audio, video and animation. Furthermore, the addition of artificial intelligence elements can expedite and facilitate mankind's tasks.
- Example: in the car design and production industry. In this case, the information system is combined with multimedia technology and artificial intelligence.

(d) Increase the understanding process and report presentation.

SUMMARY

- In today's business environment it is difficult or impossible to conduct analysis of complex problems without computerised support. Information technology enables managers at all levels to make better and faster decisions.
- In this topic, you have learnt the range of functional information systems, which consist of transaction processing system, marketing information systems, manufacturing information systems and human resource information systems. These systems are based on specific functions, but interlink with each other depending on the organisational needs.

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- Other decision making tools for higher management level include management information systems, decision support systems and executive information systems.
- Artificial intelligence and its types are introduced in this chapter. Some of the AI technologies today are used in robotics, fuzzy logic and expert systems. The use of AI has become increasingly important in our daily lives as it can help us to perform tasks more effectively and efficiently, and it is highly appreciated in strategic management level for decision making.

KEY TERMS

Artificial intelligence
Decision support system
Executive information system
Functional information system
Managing information system
Marketing information system
Online transaction processing
Transaction processing system

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Topic 10 ▶ Redesigning the Organisation with Information Systems

LEARNING OUTCOMES

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

1. Explain the concept of problem solving;
2. Explain the concept of information system planning;
3. Assess steps in information system planning;
4. Redesign the organisation with an information system; and
5. Clarify that information system development brings many changes to the organisation.

▶ INTRODUCTION

The success of an organisation starts from a detailed and effective planning process. The management plays a very important role in that process. Failure to

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formulate an effective strategic plan will cause the organisation to fall far behind its competitors in the market.

In this topic, we will look at the contributions of information systems in helping the management to conduct better and more effective planning. The information system acts as the main weapon for competing in the world of business. Redesigning an organisation with an information system is a wise step by the management if it intends to compete in the era of a world without boundaries.

Many successful organisations owe their achievements to the skill of their managements in using information systems in their daily business activities. There are also many organisations that had to close down because they could not compete in the wave of information technology.

Finally, you will learn about the methods for redesigning an organisation with an information system. This will begin with the introduction of the problem-solving concept, system development planning and organisational change with the emergence of information systems.

10.1 SYSTEM DEVELOPMENT PLANNING

Redesigning an organisation with an information system is not easy. Detailed planning has to be performed so that the information system fully assists the main activities of the organisation.

10.1.1 Concept of Problem Solving

System development is closely related to the activities of problem solving in business or the opportunity to use information system to increase organisational efficiency. We cannot deny that the information system can greatly help the organisation to perform its daily activities as well as expedite and facilitate the decision making of the management.

First, we need to understand the concept of problem solving before going on to the method for system development. Refer to Table 10.1 for important terms related to problem solving.

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Table 10.1: Important Terms in Problem Solving

Terms	Explanation
Problem	An undesirable or complex situation which will lead to negative consequences.
Problem Solving	A process or an activity that is performed to overcome a problem or to grab an opportunity so that the negative consequences can be avoided.
Decision	An outcome that has been agreed upon to plan the next step and action.
Trouble/Sign	The source of problems.

Problems that are often faced by an organisation occur because of two reasons, which are:

- External influence: Such as the political situation of a country or the world, economic stability, government policies, competitors, suppliers and customers.
- Internal influence: This may originate from staff or human resources, raw material supply management, and others.

The problems can be divided into three types, as summarised in Figure 10.1.

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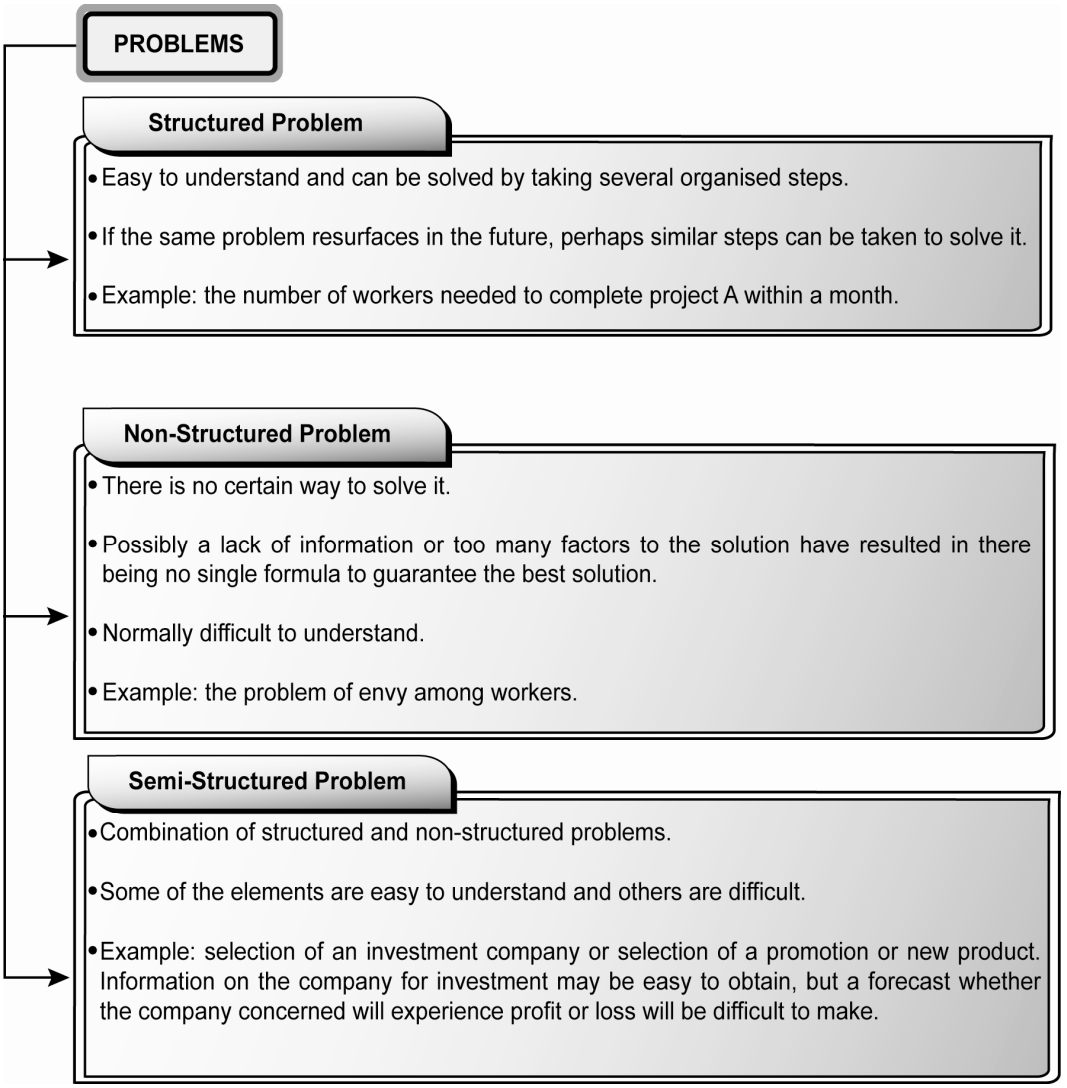


Figure 10.1: Three types of problems

After understanding the types of problems often faced by organisations, we will try to find a way to solve them. Some of the problems can be solved by using information technology. For example, the delayed calculation of salary and allowance for workers is because it is performed manually by a clerk. A salary and allowance calculation information system can be developed to solve this.

Other than to help solve problems, information technology should be seen as a weapon that can be used to take the organisation far ahead of its closest rivals. For example, the use of a website would make it easier for the organisation to be recognised and contacted by the customers.

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Problem solving is not the task of a manager alone. It is the responsibility of all parties, especially individuals who are experts in the field related to a problem. Figure 10.2 illustrates the elements that are needed in problem solving.

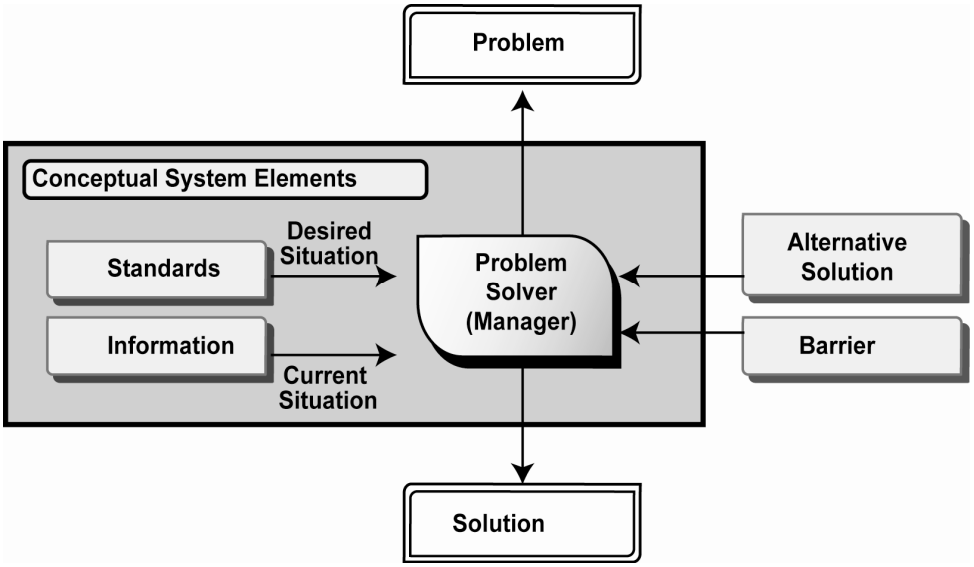


Figure 10.2: Problem-solving elements



ACTIVITY 10.1

Think about the problems in your organisation that can be solved by using information technology.

10.1.2 Information Systems and Organisational Planning

Information system planning has to be performed after all parties have agreed to redesign the organisation using an information system.

Information system planning is a process using goals, strategies, objectives and organisational information to identify and select a system that will be developed and a suitable time to develop it.

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Before the planning of an information system can be performed, several matters need to be given attention, especially by the upper management. Some of them are:

(a) The upper management must accept information technology as an important resource for overall organisational activities.

(b) The use of an information system in the organisation must be planned like other complex resources are planned. An information system comprises not only computers, but also the hardware, software, telecommunications, people, procedures and data.

(c) Information technology is a resource that is owned by all organisational staff, not only the Information System Department.

(d) The upper management must recognise the information system as a resource to achieve strategic goals, not merely as a support for problem solving.

Once the management understands these points and agrees to the use of an information system for the overall activities of the organisation, the planning of the system development can commence.

Appropriate planning and consideration ought to be given attention to ensure that the information system developed is not merely completed within the prescribed time and budget, but its implementation can be accepted by all parties involved.

There are several steps to ensure the success of the information system planning process. Figure 10.3 shows the steps necessary in the planning of an information system.

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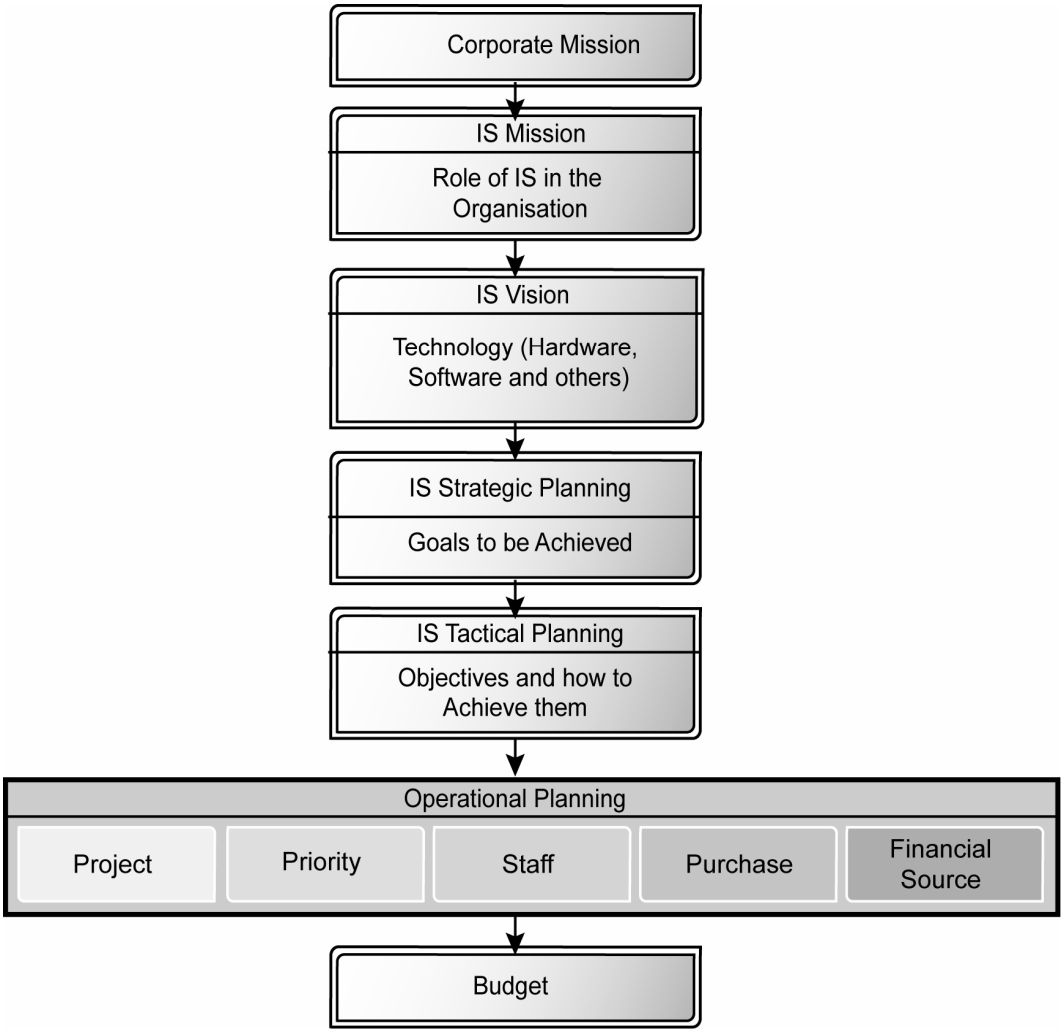


Figure 10.3: Steps for information system (IS) planning

A brief explanation for each step is as follows:

(a) **Corporate Mission**
Strategic planning starts with the corporate mission that details the overall goals and aims of the organisation. Determining the corporate mission is important because each organisational function will be focused on that mission.

(b) **Information System Mission**
The management of the information system plans the mission of the information system based on the goals of the organisation. The mission

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encompasses the goals to be achieved with the use of an information system that is consistent with the goals of the organisation.

(c) **Information System Vision**

The manager of the information system outlines the vision of the information system in relation to the hardware, software and telecommunications that can contribute to the achievement of organisational goals. For example, the customer is allowed to access the organisation's website.

(d) **Strategic Planning and Tactical Planning Information System**

Strategic planning of an information system explains in greater detail the action that has to be taken in relation to the information technology and information system facilities in order to achieve the organisational objectives. Strategic planning is normally for three to five years.

Strategic planning of an information system must fulfil the following three criteria:

(i) In line with the organisational strategic planning.

(ii) Prepares the information technology architecture to enable the user, application and database to be networked and integrated.

(iii) All resources for developing the system must be readily available for use to guarantee that all the projects will be completed on time, within the stipulated budget and that it functions properly.

Tactical planning explains how and when the strategic goals can be achieved. Tactical planning is usually made for short periods of time as compared to strategic planning.

(e) **Operational Planning**

Operational planning is related to the implementation of daily activities by considering the resources and tasks that have to be performed. Operational planning must ensure that the information system functions always fulfil their objectives. This includes addressing the barriers to those functions, like technology, finance and human resources.

(f) **Budget**

Organisational activity planning that suits the financial resource.

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ACTIVITY 10.2

Visit http://www.sabre.com/about/index.html. Explain what has been done by the SABRE management to ensure that the company is always ahead of its closest competitors in the market.



SELF-CHECK 10.1

Explain three categories of problems often faced by the management.

10.1.3 Standardisation in Planning

It is important to have standardisation in planning. Management should standardise its information technology when it decides to adopt a certain information technology resources for all its units.

Standardisation results in several benefits:

(a) **Cost savings**
When the decision is made to purchase the same hardware or software for all units in an organisation, it has better bargaining power and can obtain lower prices from vendors. This applies to purchasing computers of all classes, as well as licensing software.

(b) **Efficient training**
It would be easier to train employees how to use a small variety of software than to train them how to use a large variety. Less trainer time would be required; employees would spend less time on training and more time on their normal tasks. This would save cost by having fewer labour hours spent on training.

(c) **Efficient support**
Standardising on a small number of computer models and software applications enables the IT staff to specialise in the hardware and software they have to support. The more focused skills make it easier for the organisation to recruit support personnel, and the users would be more satisfied with the support service.

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10.1.4 From Planning to Development

After planning on the new information system, the management should decide how to obtain the systems. In most cases, "systems" means software. Customer Relationship Management and Supply Chain Management systems, as examples, rarely require specialised hardware. There are increasing numbers of new systems ready to be purchased and customised for an organisation's needs, compared to in-house development of systems.

The approaches of systems development are the same regardless of who develops the system – either the organisation or its vendor. We will look into systems development in the next segment.

10.2 SYSTEM DEVELOPMENT AND ORGANISATIONAL CHANGE

We have discussed the matters related to information system development and strategic planning as well as problem-solving methods.

Designing an information system for an organisation does not simply mean developing and using an information system in the organisation. The main goal is to help solve the organisation's problems as well as increase work quality, and thereby, produce high-quality products or services.

If this goal is not achieved, and the use of the information system adds to the organisational burden, the management should perhaps think it over.

10.2.1 Organisational Change

The restructuring of the organisation with an information system will directly or indirectly affect the daily activities of the organisation. The changes brought by information technology have to be realised so that the function and task for each party will proceed smoothly with the use of information system. This change is normally divided into four parts, as shown in Figure 10.4.

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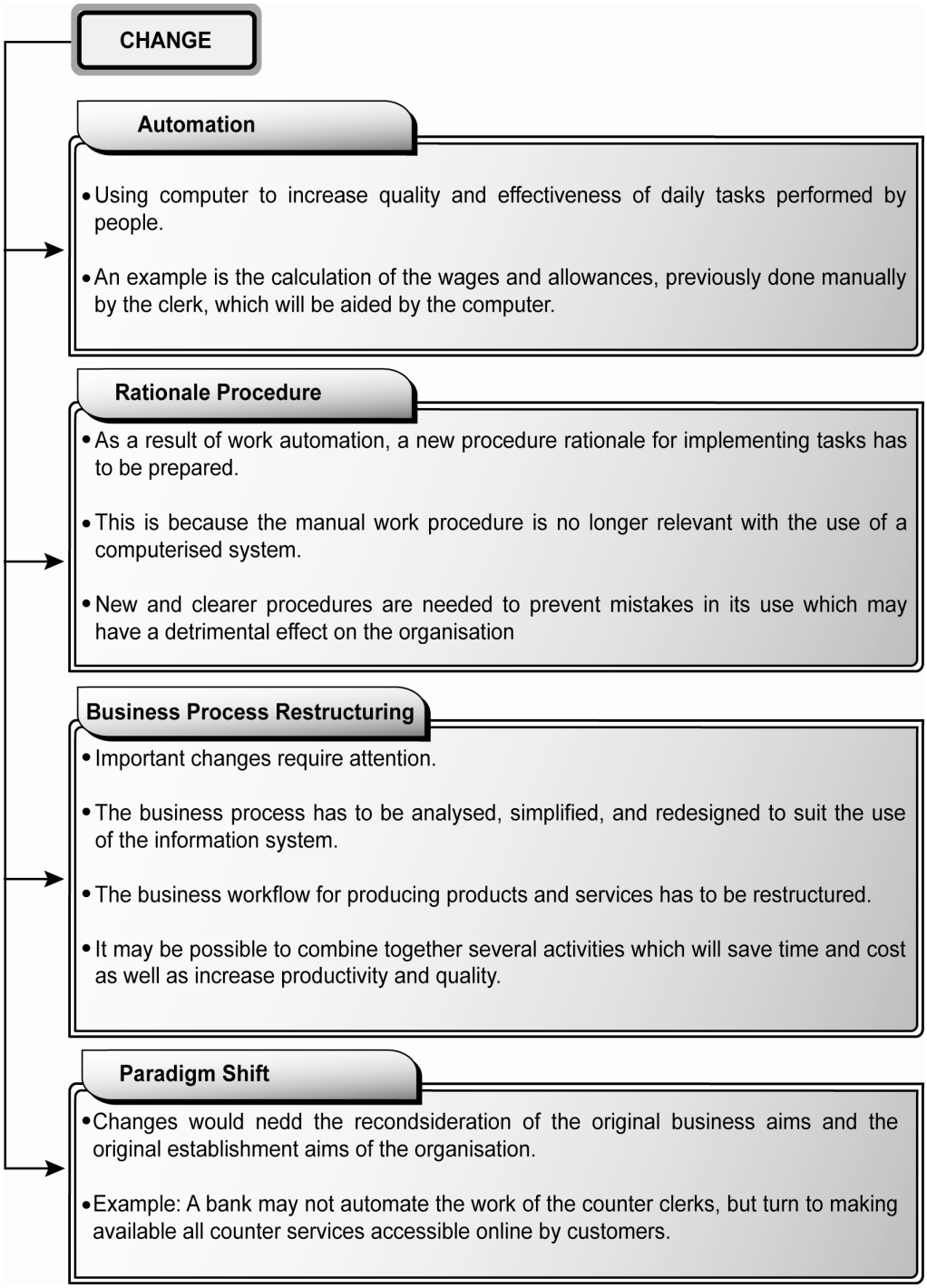


Figure 10.4: Changes brought about by information technology

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ACTIVITY 10.3

Refer to the book by Laudon, Kenneth C. and Laudon, J.P. (1998) Management information systems – New approaches to organisation and technology (5th Ed.) Prentice Hall Inc.



SELF-CHECK 10.2

Explain the changes that may occur in an organisation with the implementation of an information system.

SUMMARY

- You have learnt about the importance of information technology in helping to solve problems and taking the organisation forward and ahead of its competitors. The types of problems often faced by organisations – structured, non-structured and semi-structured – determine how the planning of IT implementation could be done to solve them.
- The seven steps of information system planning considers the organisational aspect, ensuring that the implementation of IS would be aligned with the business needs. Information system planning is important especially when investing in IT is typically great due to high risk in its implementation. Thus, standardisation is much needed to efficiently plan for the IT implementation. Standardisation helps in cost saving and the provision of effective training. It also results in efficient support.
- The organisational changes that may occur with the use of information systems are briefly discussed as early preparation for all parties involved.

KEY TERMS

Automation

Information system development

Information system planning

Paradigm shift

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Topic 11 ▶ Methods for System Development and Alternative Methods for System Development

LEARNING OUTCOMES

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

1. Define System Development Life Cycle;
2. List the phases of the System Development Life Cycle;
3. Explain the task and role of each phase of the System Development Life Cycle;
4. Discuss the result that is obtained in each phase in the System Development Life Cycle;
5. Evaluate the alternative methods for system development;
6. Assess each alternative method in system development;
7. Appraise the advantages and disadvantages of each alternative method; and
8. Propose an alternative method for developing a system that is most appropriate for a given problem.

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▶ INTRODUCTION

You have learnt and understood the importance of information system planning in an organisation before developing a system. The failure to plan an information system well will result in the failure of its development and implementation process.

In this topic, you will learn about developing an information system using the System Development Life Cycle (SDLC), which is very popular.

You will be exposed in greater detail to the phases involved in the SDLC. Understanding the tasks and roles of each phase is important to avoid making mistakes in the next phase. The results obtained at the end of each phase also influence the next phase.

The process of system development that uses the SDLC method involves a long period and quite a high cost. Many alternative methods can be used to develop a system. We will look at several examples of these alternative methods. Knowledge of these methods is necessary to assist the management before a decision to develop the system is made. This is because a good system need not necessarily be developed by the organisation itself. A good system is one that could fulfil the needs and objectives of the organisation.

After reading this topic, it is hoped that you could make the best decision for your organisation in developing a system using a suitable method.

11.1 SYSTEM DEVELOPMENT METHODS

11.1.1 System Development Lifecycle

System Development Life Cycle (SDLC) is a traditional system development method that is still used in organisations today.

> The SDLC reflects a structured framework that is organised in the process of system development.

The main phases in the SDLC are investigation, analysis, design, programming, testing, implementation and maintenance. We will discuss each phase in greater detail. The SDLC is illustrated in Figure 11.1.

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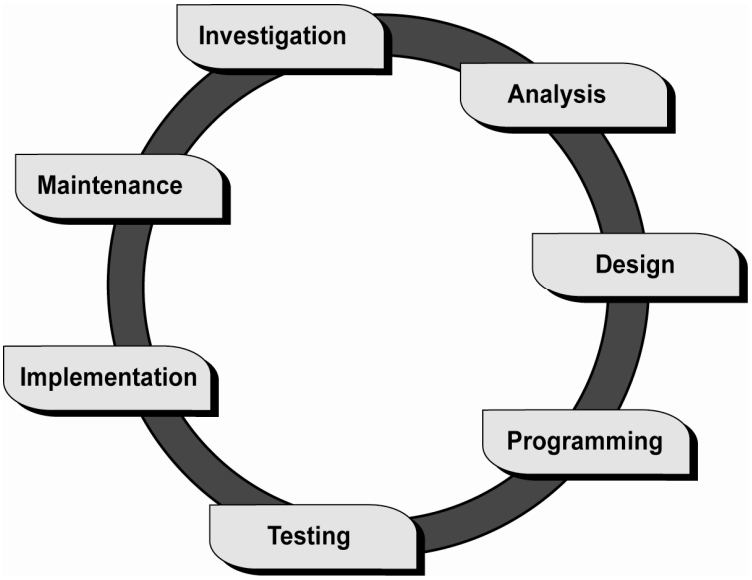


Figure 11.1: System development life cycle

11.1.2 Investigation

An important task in this phase is early studies to identify whether the system that will be developed is actually suitable and can fulfil user requirements. They will identify the resource needs, cost, benefits that will be obtained, and success factors of the system to be developed.

The early studies can be divided into four parts – early organisational study, early technical study, early economic study and early operational study. A summary of these early studies is illustrated in Figure 11.2.

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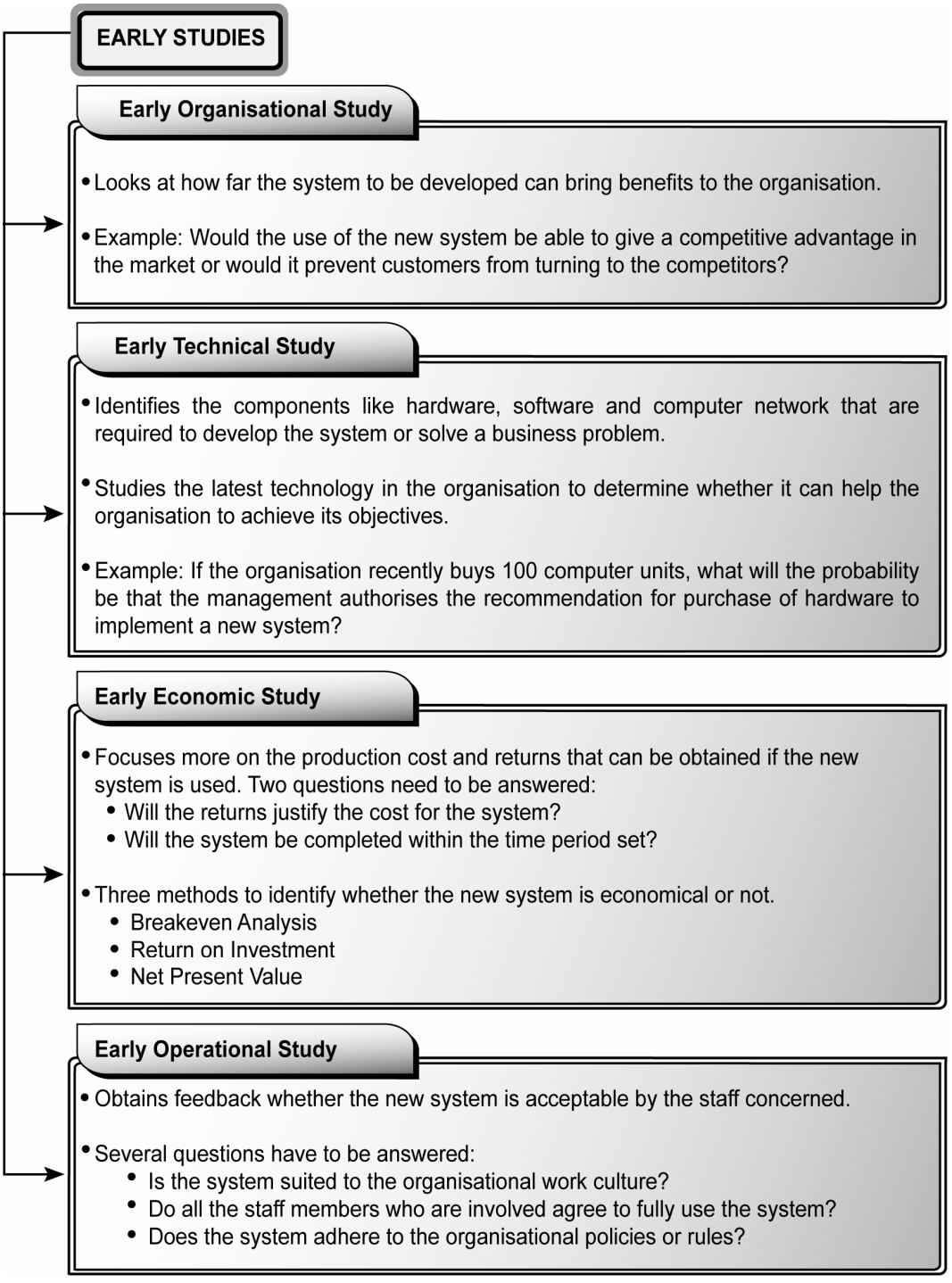


Figure 11.2: Parts of early studies

The division of early studies is shown in Table 11.1.

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Table 11.1: Summary of the Division of Early Studies

Organisation	Economy
• The developed system is able to increase organisational competitiveness	• Saves cost • Adds to profit • Reduces the need for resource investment • Increases income
Technical	**Operational**
• Hardware • Software • Network	• Acceptance by workers, customers and suppliers • Support from the management • Government or other needs

Results of Early Studies:

A report recommending whether the new system should be developed or otherwise.

11.1.3 Analysis

The analysis phase will only be performed after agreement to develop a new system is achieved in the investigation phase. In this phase, a study is conducted to understand the business problems that the organisation plans to solve using an information system.

Analysis Objectives:

- To obtain information related to the existing system.
- To identify the needs of the new system.

A study of the business problem encompasses:

- Definition of problem.
- Identification of problem source.
- Solution to the problem.
- Identification of required information to solve this problem.

There are three methods for solving problems, which are by:

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- Not making any changes, using the existing system, or;
- Modifying and updating the existing system, or;
- Developing a new system.

The information that can be obtained in this phase includes:

(a) Advantages and disadvantages of the existing system.

(b) The functions that must exist in the new system to solve problems.

(c) User requirement information for the new system.

Analysis Result:
System requirement documentation for solving the problem

11.1.4 Design

Designing is the next step after the problem analysis. The main function of this phase is to clarify how the system can carry out the task of solving the problem.

System design is divided into two parts, which are the logical system design and physical system design. The explanation for both parts is summarised in Table 11.2.

Table 11.2: Design Specifications for Logical and Physical System Designs

Logical System Design Specification	Physical System Design Specification
Explains the tasks that the system will perform.	Explains the function that the system will perform.
Abstract type specification.	Actual physical specification.
Includes the designs for input, output, process, database, telecommunications, control, security and tasks of the information system.	Includes the design of hardware, software, database, telecommunications and procedure.

After the design specifications are agreed upon by all parties involved and an agreement is signed, no further changes are permitted.

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Design Result:

System design specification.

11.1.5 Programming

Once a suitable design has been identified, programming will be carried out to translate the system design specification prepared by the system analyst into a programming code. The selection of a suitable programming language is made according to the requirements of the system.

The task of writing the programming code is performed by the programmer. It may be carried out by more than one person depending on the complexity of the system that is being developed. The system will be divided into several modules before they are combined in the final phase of programming.

Programming Result:

A complete system programme.



SELF-CHECK 11.1

1. Describe the analysis phase.
2. Write two parts of designing a system.
3. Identify the information that is obtained from the analysis phase.
4. What is the end result of the programming phase?

11.1.6 Testing

The testing phase is performed to identify if there are any mistakes (errors) in the programming that has been developed. There are two types of errors, which are:

(a) Syntax error
   (i) Normally easy to detect, like missing commas and wrong spelling.

(b) Logical error
   (i) This is an error in the processing that will cause an error in the result produced.

   (ii) Quite difficult to detect.

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ACTIVITY 11.1

Can you give an example of an error that falls under the logical error category?

Testing Objective:

To ensure that the programming code does not contain any errors and the system runs smoothly.

The process of testing will be performed in stages. Normally in programming, the system will be divided into several modules. Tests will be performed on each module. After completion, testing on the whole system is carried out to ensure that the following features run smoothly:

- Integration of interfaces for every module.
- The system functions on the required platform.
- The system can support the capacity of data that is required.
- The system fulfils user needs.

Testing Result:

The system program is complete and free of errors.

11.1.7 Implementation

If the testing phase occurs without problems, this means that the system is ready to be used. The next step is to make the required preparation to deploy this new system.

Implementation definition:

This is the process of changing the old system to the new system.

Four strategies can be used to change the system, as illustrated in Figure 11.3.

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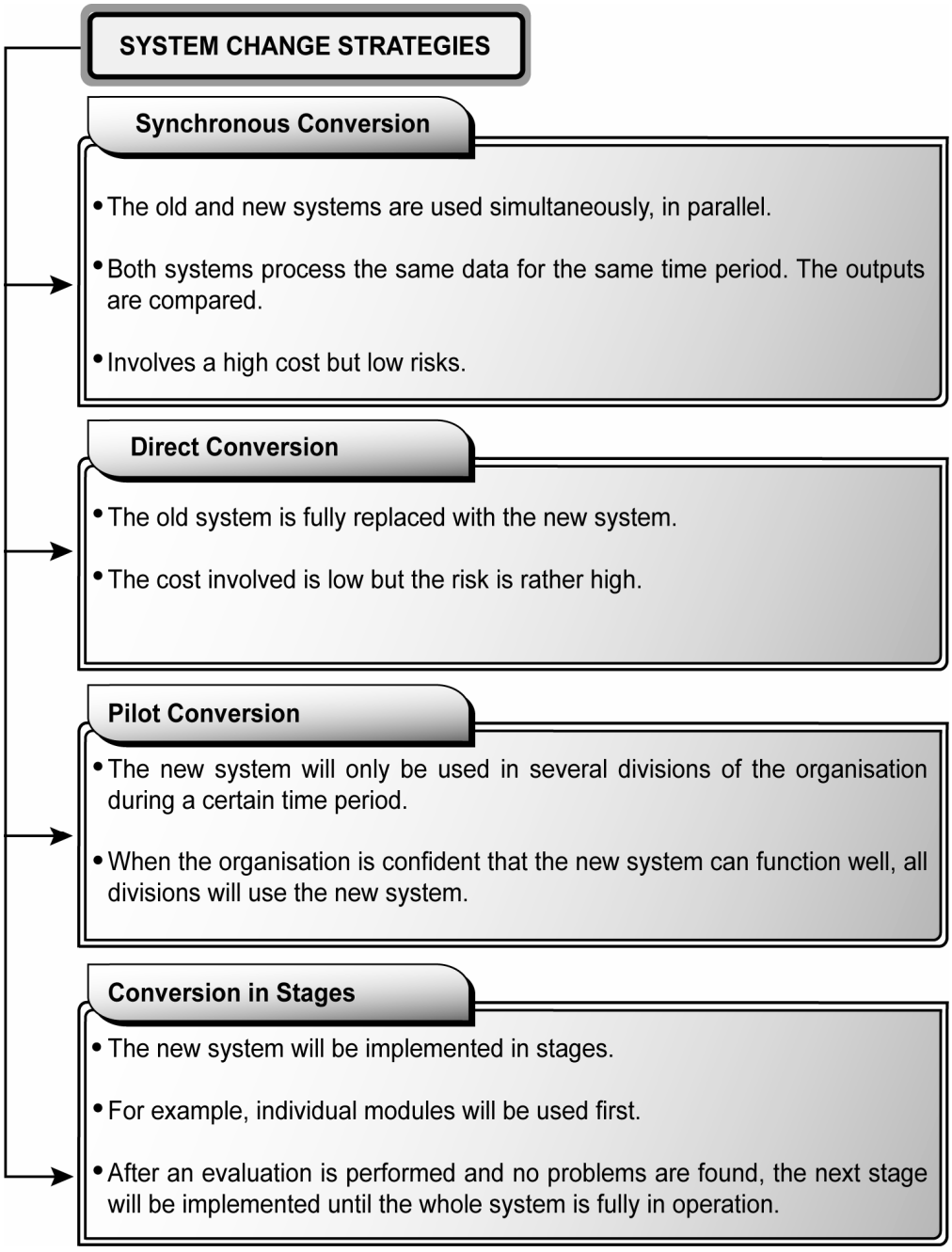


Figure 11.3: System change strategies

11.1.8 Maintenance

This new system that is in operation will be studied again after a certain period of time. This is to ensure that the user objectives are still being met.

Maintenance objectives:

To ensure that the system continues to fulfil the user objectives.

The process of maintenance needs to be performed to ensure there are no major problems during the life time of that system. Maintenance is carried out by re-testing the program and modifying the system so that it is in line with the changes that occur in the organisation or business. This process is made without adding to the functions of the system.

There are also maintenance procedures that have to be added to the system functions. This process is performed by adding new features without disturbing the operation of the system.

Maintenance Phase Result:

The system runs smoothly.



SELF-CHECK 11.2

1. Explain the strategies in implementing a system.
2. Elaborate on the reasons for performing maintenance.

11.2 ALTERNATIVE METHODS FOR SYSTEM DEVELOPMENT

11.2.1 Prototyping

The prototype model is normally used when the user requirements are difficult to obtain during the early stages of system development. The developer of the system will develop a prototype as a demonstration of the actual system to the user. The user will comment and give suggestions about the model that is developed to meet his requirements. The system developer will then modify or adjust the system to reflect the requirements of the user. This is an ongoing process until the user agrees with the characteristics of the system or cancels it. Figure 11.4 shows the flowchart of a system development using this model.

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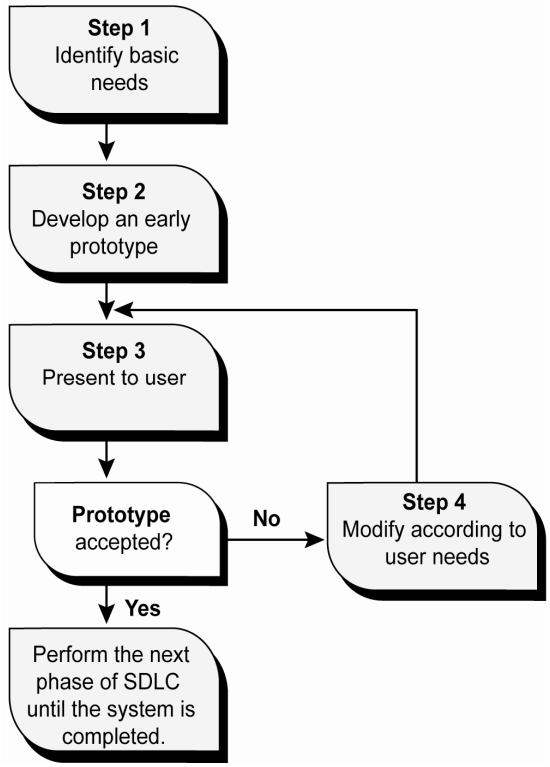


Figure 11.4: System development flowchart using the prototype model

There are three approaches in developing a system according to this model, which are:

(a) Develop a user interface first without involving any programming. This is to illustrate to the user the system that will be developed.

(b) Develop the first phase of the system that is limited to several functions.

(c) Use the existing system or one of its components to show a function that can be inserted subsequently into the system development.

Some of the advantages of using the prototype model are:

(a) Expedites the process of developing a system.

(b) Enables the user to clarify his needs after viewing the system prototype model.

Since the prototype model combines the analysis and design phases, there is a possibility that the system analyst may provide inaccurate information in the documentation to the programmer. This matter may give rise to problems in the deployment and maintenance phases.

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11.2.2 Joint Application Design

Joint Application Design (JAD) is a method of gathering information relating to the user needs, and system design in the SDLC phase is performed as a group.

JAD objective:

To define the project, design a solution and control the project until completion.

The system analyst will hold a meeting for all individuals involved with the system that will be developed. Discussions relating to the requirements of the new system will be held and all parties have the right to voice their opinions. An agreement regarding the system requirements will be formulated at the end of the discussion.

Some of the **advantages** of JAD are:

(a) Involves many users at a low cost.

(b) The new system is agreed upon and supported by all parties.

(c) The new system produced will be of higher quality.

(d) Facilitates the implementation process.

(e) Reduces training costs.

The **disadvantages** of using JAD are as follows:

(a) Difficult to gather all users at one time, especially in a large organisation.

(b) There is the possibility that several parties will control the meeting and some parties will be too shy to voice their opinions.

(c) Difficult to collaborate various ideas especially when too many ideas given and proposers insist of implementing the idea.

(d) Possibility of feature creep that could cause issues of keeping on schedule. Feature creep occurs in the development process when the specifications are changed by adding new features, results in additional costs and missed deadlines.

The solution to this problem is to elect a facilitator in the meeting who has knowledge of system analysis and design, as well as how to conduct the meeting. People management and good leadership skills are required as well for the facilitator to possess, to ease the process of managing the system development project.

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11.2.3 Computer Assisted Software Engineering (CASE)

CASE tools are often used to automate tasks in the SDLC. The tools that automate the early phases of the SDLC (investigation, analysis and design) are known as upper CASE tools. The tools that automate the following phases of the SDLC (programming, testing, implementation and maintenance) are known as lower CASE tools. Tools that integrate the upper CASE and lower CASE tools are known as the Integrated CASE (ICASE) tools.

In general, the CASE tools contain various software tools, as shown in Table 11.3.

Table 11.3: List of Software Tools

Tool	Function
Diagram	Enables processing, information and data flow, and controlled structures to be presented in graphical form.
Analysis	Automatically verifies all matters related to inappropriate solutions, uniformity, specification errors in the diagram, screen and report.
Repository	Enables the integration of storage specification, diagram, report, data name and data definition.
Documentation Generator	Helps in producing technical documentation and user documentation according to established standards.
Code Generator	Automatically generates program codes and database definition from the design, diagram, screen and report documentation.

Some of the advantages of using CASE tools are:

(a) A system that better fulfils the user requirements can be produced.

(b) The process of developing the system is much faster.

(c) CASE tools can help to produce good documentation.

The disadvantages related to the use of CASE tools are:

(a) A high initial cost for making available the various CASE tools.

(b) The user requirements have to be defined in a wider and more accurate sense.

(c) It may be difficult to use and may take time to learn to use it.

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SELF-CHECK 11.3

1. Explain the advantages of using a prototype model.
2. Why is the prototype model said to create problems in the deployment and maintenance phases?
3. How can a system development using the JAD method be implemented?
4. Explain the disadvantages of using JAD.

11.2.4 Rapid Application Development

Rapid Application Development (RAD) combines the JAD development method, prototyping and CASE tools to produce a high quality system.

In the early stages, the JAD method is used to collect the user requirement information. Then, the CASE tools are used to develop a prototype model. The prototype model will be presented to the user in a JAD session to obtain the comments and opinions of the users.

The RAD method is suitable for developing a system quickly, while maintaining the quality. Figure 11.5 shows the system development model using the RAD model.

Normally, the RAD software package contains the following components:

(a) A collection of graphical user interfaces that are readily available for use just by clicking on certain buttons.

(b) Reusable components, including buttons and objects, are treated as libraries.

(c) A code generator that automatically generates the programming code or a report after the user selects certain components.

(d) A programming language like Visual Basic or C++ that is integrated with the development, testing and programming code checking environment.

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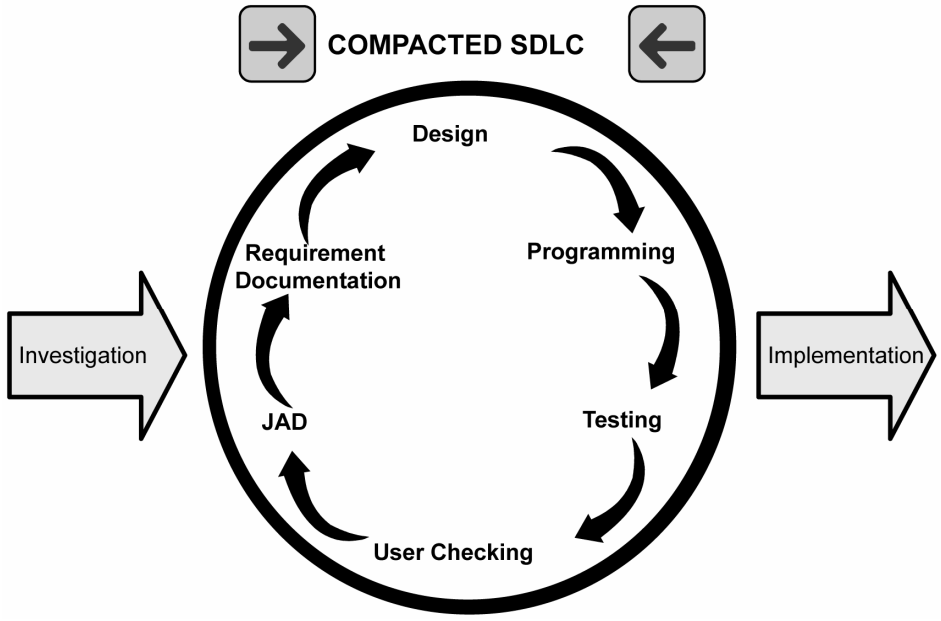


Figure 11.5: RAD model

Some of the **advantages** of RAD are:

(a) Expedites the development of the system.

(b) Reduces the cost of developing the system.

(c) Actively involves the user from the early stages of development through to the implementation stage.

(d) Facilitates the implementation stage.

(e) Reduces the training costs.

The **disadvantages** of using RAD are as follows:

(a) The functions and comprehensiveness of the system may be limited because of the time factor.

(b) The system is difficult to modify according to the changes that occur within the organisation.

(c) There is a possibility that certain processes are not documented or poorly documented.

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11.2.5 Object Oriented Development

The development of a system using the SDLC method requires that we follow certain established steps or phases. A system that is developed using the SDLC is normally suitable for a certain type of problem only. The same database may be involved, but with the emergence of different problems, other systems may have to be developed to solve them. For example, a system for the salary payment of workers cannot be modified to become a system to record workers' leave.

The development of a system using the object oriented method does not start by performing a certain task. Each object that is involved in the system is modelled as close as possible to real life. For example, a customer object will have characteristics like name, address and telephone number. The same goes for other objects. A good model will enable the same information to be used by many systems that are related to that object.

The advantages of using the object oriented development method are:

(a) Reduces the complexity of development of a system and facilitates maintenance as each object is normally small and easy to manage.

(b) Increases productivity and quality of programming because when an object has been built and has gone through the processes of testing and deployment, it can be reused in other systems.

(c) The system built is more flexible. Modifications can be made by changing certain objects.

(d) It is suitable for developing web based systems.

Some of the disadvantages of developing a system using this method are:

(a) Many systems that use the Java programming language are slow in execution.

(b) Not many programmers are skilled in object oriented programming. Therefore, training is required.

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SELF-CHECK 11.4

1. Explain the meaning of Rapid Application Development (RAD).
2. Discuss the disadvantages of developing a system using the RAD method.
3. Elaborate on the meaning of object in object oriented development.
4. Discuss the advantages of developing a system using the object oriented development method.

11.2.6 End User Computing

The development of current computer technology has enabled the user to build his own information system. A not too complex information system can be developed with the aid of software that is becoming even more user friendly.

The professionals in information technology still need to manage and control the hardware, software, data and network which are required to support the computer system. Other than this, they are also responsible for developing complex systems.

Table 11.4: Categories of End Users

Category	Activity
End users who are not programmers	Enter data, use readily available applications
Normal users	Access data, print reports
End users who are programmers	Develop applications for their own use
Functional support personnel	Develop applications for the use of others
End user computing support personnel	Give training, hotline, help users to develop applications
Programmers	Develop complex applications

The skill of the end user can be improved from time to time based on either experience or training. Other factors that may contribute to the improvement of computing skills of the end user are as follows:

(a) Advancement of computer hardware
   (i) Makes available more user friendly software to be used.
   (ii) Users do not need to have programming skills in order to develop simple systems.

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(b) Lower prices for hardware.
    (i) More people can afford to buy it.
(c) Increase in the number of software applications with high functionality.
(d) Computer savvy population increases.
(e) Process of developing systems is faster.
(f) Many of the systems developed are business oriented.

The advantages of end user computing are:
(a) The user is able to control the process from development to maintenance.
(b) The system completely fulfils the user needs.

However, there are some disadvantages of its use:
(a) Some users claim that system development require complicated hardware. This may burden the organisation.
(b) There is a possibility a low quality system is produced because of weak programming techniques and incomplete documentation.

11.2.7 Third Party Development

The need for information technology in today's organisations is becoming more pertinent. However, not all organisations have their own information technology department that can develop and maintain the organisational information system. Because of the need for an information system, an organisation may appoint a third party to develop the system which can fulfil the business needs. This method of developing a system is called development by a third party or outsourcing.

Outsourcing

This can be described as buying a product or obtaining a service from an external organisation.

Examples:

(a) Purchase of computer hardware, office furniture and others from other organisations.
(b) Even though they are bought from other organisations, all the hardware and furniture must fulfil the needs of the organisation according to the standards that have been established.
(c) Information system development services.

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(d) The organisation appoints an external organisation to develop the desired information system.

(e) The process of development follows either the SDLC method or an alternative method. The only difference is that the information system is developed by outsiders.

(f) Normally, the organisation has to pay only for the completed system.

Some of the **advantages** of development by a third party or "outsourcing" are:

(a) The focus of the organisation can be placed on the business rather than having to worry about system development.

(b) The organisation can benefit from the expertise of another organisation that develops the system.

(c) The cost can be estimated more accurately.

(d) The organisation is able to compete by using information technology without needing to have expertise in that field.

(e) It reduces the cost of developing a system.

(f) The time span for development can be estimated more accurately.

(g) It reduces the time of developing a system due to the ensured expertise of the outsourced company.

However, the **disadvantages** are:

(a) Decrease in the number of the organisation's information technology experts in the future.

(b) Decrease in the level of control over the secrets of the organisation.

(c) Exposure of the organisation's information technology strategy to external parties.

(d) Increase in the level of dependence on external organisations.

(e) Possibility of inaccurate specifications of the developed system and recurring explanations on the requirements that consumes or takes up the development time, due to the inability of the outsourced company to understand the organisation's needs on the system since they are not from the same industry as the organisation.

(f) (e.g.: A construction-based organisation that requires a unique structure for project management system with multiple levels of approval for outgoing online correspondences with reroute feature may not be understood by the outsourced company.)

Looking at the disadvantages of third party development, it shows how important the initial analysis stage is. At this initial stage, it is important to prepare comprehensive documentation on organisational requirements of the

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information system. These two aspects could overcome the issues of miscommunication and misunderstanding on the outsourced company's side.

11.2.8 Purchase of Ready-made Software

The purchase of ready-made available software from the market is the easiest and quickest way to implement a new system in the organisation. There are many systems in the market and the management has only to make a selection based on the needs of the organisation.

However, there are some systems that have to be modified before deployment so that they are in line with the needs of the organisation. Figure 11.6 shows the method of buying software from the market by the management.

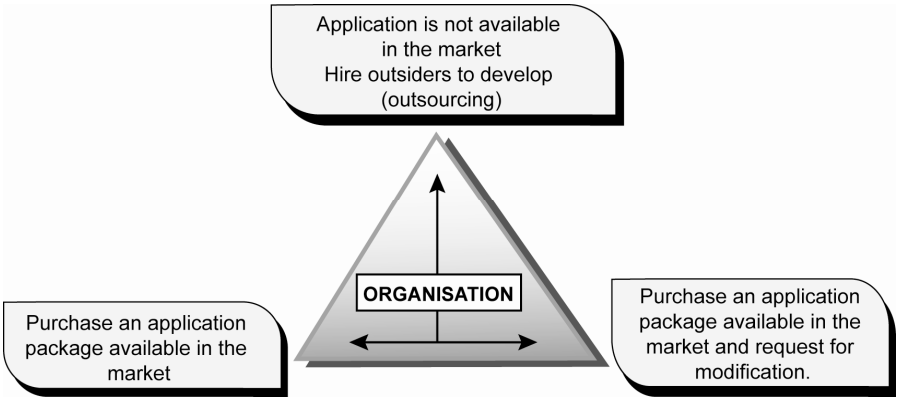


Figure 11.6: Method of buying software

Some of the advantages of purchasing available software are:

(a) Easily and quickly obtained because many complete systems have been developed.

(b) There is no cost associated with development.

The disadvantages include:

(a) Difficulty in finding a system that completely fulfils the needs of the organisation.

(b) The cost for modification may have to be shouldered by the organisation.

(c) The reliability of the system is fairly low.

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SELF-CHECK 11.5

1. Explain what is meant by outsourcing.
2. When can system development by outsourcing be done?

SUMMARY

- You have learnt the methods for developing a system using the SDLC. The SDLC is divided into seven main phases, which are investigation, analysis, design, programming, testing, implementation and maintenance.
- The tasks and roles of each phase have also been described. At the end of each phase, the result that is obtained will help in the following phase. The SDLC will continue to turn in line with the life time of a system.
- You have also read about the alternative methods to develop an information system. Each of these methods has its own advantages and disadvantages.
- Before choosing an appropriate method for developing an information system, we must consider the size and complexity of the system as well as the current situation of the organisation.
- In summary, the wisdom of the management in making a decision in the development of an information system will give a positive impact to the organisation.

KEY TERMS

Computer Assisted Software Engineering (CASE)
Joint Application Design (JID)
Logical error
Prototype model
Rapid Application Development (RAD)
Syntax error
System Development Life Cycle

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Topic 12 ▶ Success and Failure of Information System Implementation

LEARNING OUTCOMES

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

1. Identify the major problematic parts in information systems;
2. Assess whether a system is a success or otherwise;
3. Analyse four main factors that cause the failure of a system;
4. Appraise the relationship between implementation process and system result; and
5. Propose a suitable strategy to manage the information system implementation process.

▶ INTRODUCTION

People are racing to use information technology in order to implement information technology infrastructure in their respective organisations. Would the use of information technology guarantee higher returns? The fact is, the use of information technology that does not start with clear goals and comprehensive planning will not guarantee positive results.

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In this topic, we will look at the important aspects in implementing information technology, starting with the introduction to the problems that may arise from the implementation of information technology, the sources of these problems, and how to measure the success of the implementation. Then, we will discuss the implementation steps of a planned information technology project to ensure that maximum returns are achieved.

12.1 INFORMATION SYSTEM FAILURES

Even though an information system has been developed, it may still be viewed as a failure. The failure of an information system may be due to the weakness in implementation during the information system development process or shortcomings in the management of information technology after the system has been developed.

There are also systems that have been completed but not used as originally planned or not used at all. How is it that an investment that entails a huge cost, time and energy can be left unused? Some of the reasons that can be identified are the system produced is difficult to use (if compared to the existing system) and that the data is not reliable.

12.1.1 Problematic Areas in Information Systems

Generally, many organisations fail to achieve the competitive advantage that they hope for with the implementation of an information system or the use of information technology in their organisations. Research has shown that this is a common situation in many organisations. What brought about the failure? Some of the parts that may present problems in the implementation of information technology are design, data, cost and operation.

A system is said to be a failure when the design fails to fulfil the needs of the organisation or fails to enhance the achievements of the organisation. Even though the system is able to produce the required output, the output or information may not be produced on time as required, or it is not in the form required, or perhaps it is not produced within the given time frame. Therefore, the system can be viewed as being a failure. Furthermore, a system may have all the features as expected, but only lacks a good and user friendly interface. This would mean that the system is, among others, difficult to use, annoying, slow and the validity of the data entry is difficult to confirm.

Problems are often related to the data received by the system as input. If the data is inaccurate or inconsistent, wrong, ambiguous, can be hijacked, or cannot be

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accessed, then we can conclude that the system has failed. In some situations, the profit gained does not justify the high cost that has been invested.

Many operational problems can arise, such as the system does not run smoothly, is always breaking down, experiences delays in producing an output, and feedback is slow.



ACTIVITY 12.1

Of the four problems described above, which do you think is the most serious? Justify your answer.

12.1.2 Evaluating System Success

How can we measure or evaluate the success of the implementation of an information system in an organisation? Evaluating whether the system is a success or a failure is not an easy task. Different individuals may have different opinions, beliefs, values and views of the same system. Success for one individual may be failure to another.

To complicate matters, the end user and the organisation may have different evaluations. What is liked by the user in an information system may not fulfil the needs of the organisation. The system may not be able to increase the performance of that organisation.

Nevertheless, there should be a mechanism for measuring the success of a system implemented. This will identify which aspects of the system need to be improved. We can measure the success of a system based on five criteria, as briefly shown in Figure 12.1.

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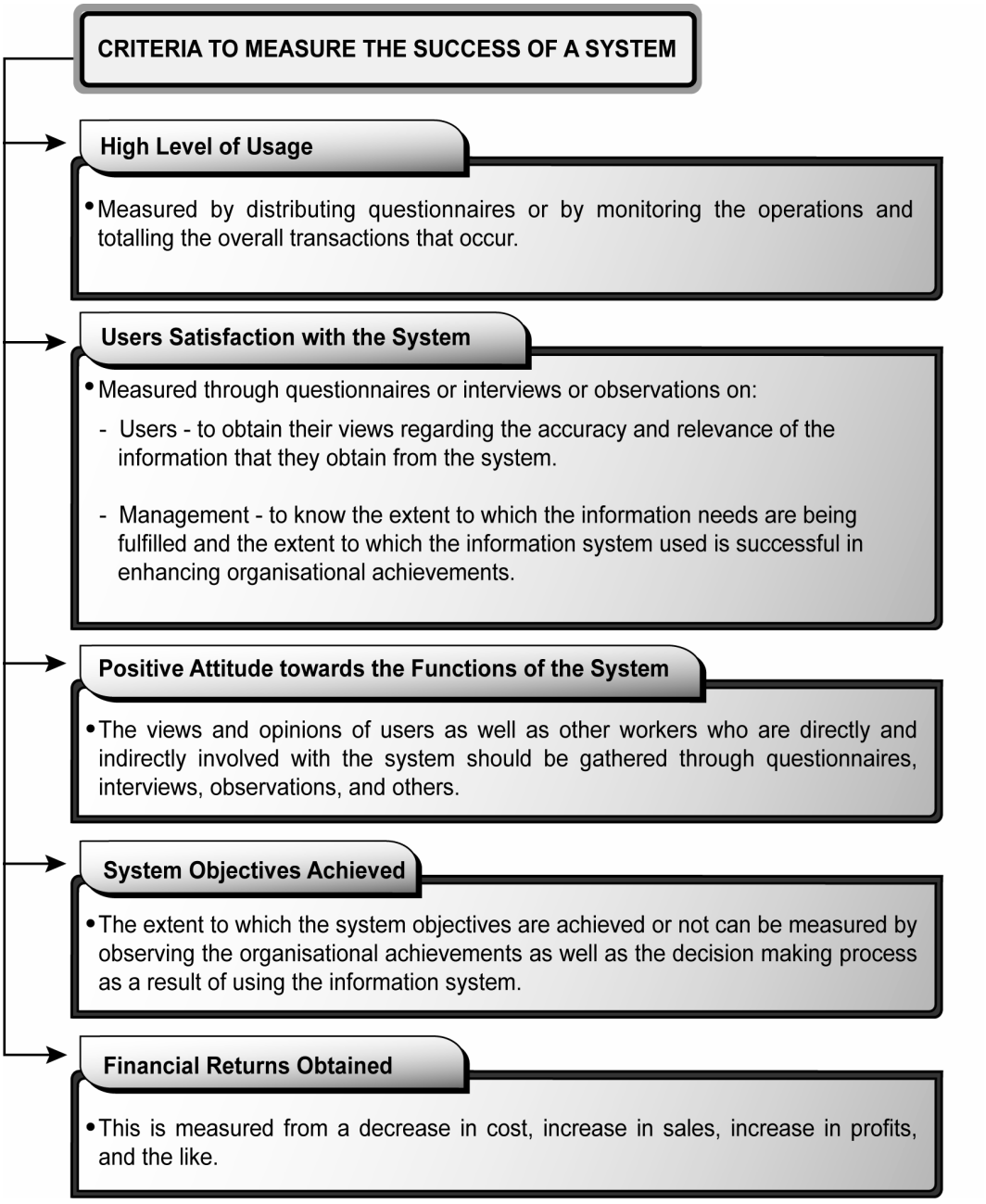


Figure 12.1: Measurement criteria for the success of a system

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SELF-CHECK 12.1

Discuss five criteria for measuring the success of a system.

12.2 REASONS FOR SUCCESS/FAILURE OF INFORMATION SYSTEMS

How is an information system first used in an organisation? In the previous unit, we listed the reasons that can initiate system development. We can conclude that it is the result of external factors (pressure from the environment) or internal factors (pressure from within the organisation) or a combination of both factors.

Not all information systems built are successful in achieving their goals. Research has shown that many developed information systems do not fulfil the needs. The important point to learn from this fact is the importance of the development and management of the system must be made with a clear understanding and consideration of the experience of other implementations.

12.2.1 Reasons for Success and Failure

From the previous discussions, it can be said that it is quite difficult to create a specific formula to guarantee the success of a system. However, there are some factors that can have an impact on the success of the information system implemented in an organisation, as summarised in Figure 12.2.

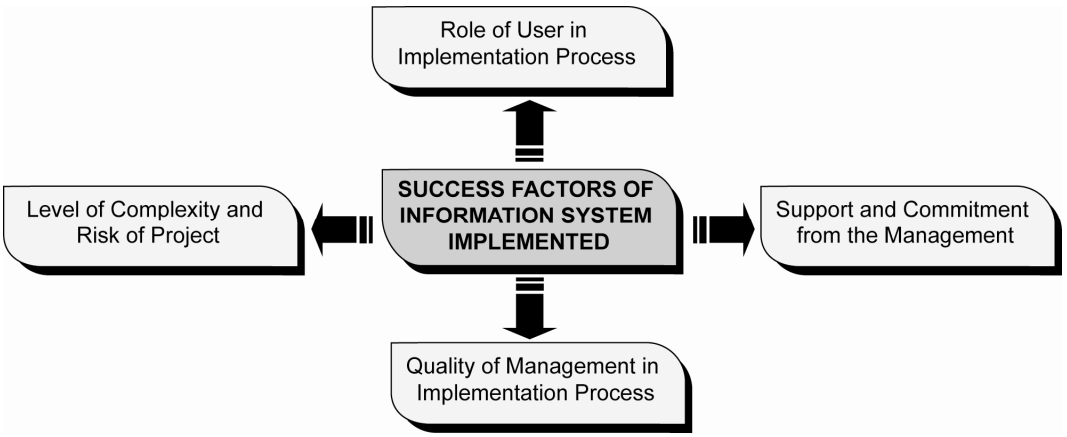


Figure 12.2: Factors that affect the success of information system implemented

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(a) **Role of User in Implementation Process**

The lack of user involvement in the development of a system usually has a negative impact on the output to be produced. The end user is the most knowledgeable person in the field, task or job that involves him. He knows better the aspects that have to be given priority or those that will give rise to the most problems.

Nevertheless, the views of the end user still have to be clarified with regard to the scope because the end user has only limited knowledge about the whole organisation. He may know about the processes that are closely related to his work, but is less familiar with the overall problems faced by the organisation.

Another advantage of involving the end user is his readiness in accepting change. If he is involved from the early stages, at least he will be aware of the changes that will take place and will be able to take steps to prepare for these changes.

A problem that often usually arises is the large communication gap between the system developers and their clients. They speak in a different 'language' according to their backgrounds which can sometimes give rise to misunderstanding between them (one party will interpret what is said by the other party according to the first party's understanding, which clearly is not what is meant by the second party). In solving a problem, the system developers may tend to use machines, techniques or certain formulas, while the customers or users are more oriented towards solving business problems which would facilitate their work in the organisation. This communication gap can cause the specifications requested by the users to be omitted from the system that is to be built.

Sometimes the project being implemented is very big and takes a long time to complete. The continuous involvement of users would affect their daily work.



ACTIVITY 12.2

What may happen if the user is not involved at the early stage in the system development process? In your view, would this be a serious problem?

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(b) **Support and Commitment from the Management**

A lesson to be learnt from the success of certain organisations in benefiting from the use of information technology is the huge amount of support from the management (from the highest to middle levels of management) and the end users in the information system implementation and technology management in the organisations. Failure often results when the system that is being developed is abandoned because management has not given their support – because they are not ready to invest in developing the system. Without serious involvement, the management will not be able to benefit from the information system in order to enhance the organisation's business processes. An important strategy to be considered in this situation is the establishment of a certain structure within the organisation that ensures the involvement of these parties in the planning and management of information technology usage in organisational activities.

(c) **Level of Complexity and Project Risks**

The process of developing a system also faces high risks and complexities. Mega projects that involve large changes in organisations like business process reengineering (BPR) or enterprise resource planning (ERP) have a large potential of experiencing failure or cannot be completed in the prescribed amount of time.

What are the factors that can determine the level of risk and complexity of an information system development project? The researchers in this field have categorised three main dimensions with the potential to influence the level of risk, which are:

- Project size.
- Project structure.
- Level of technical experience of system developers.

Mistakes often occur in estimating the level and size of projects because of lack of experience or incomplete studies.

(d) **Quality of Management in Implementation Process**

Inefficient management of the implementation process will result in the actual cost rising above the estimated cost, failure to meet the deadline, technical errors that result in a lower level of achievement from that expected, failure to achieve estimated profit and other negative outcomes.

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ACTIVITY 12.3

In Malaysia, have you come across any information system development projects that have been abandoned?

12.2.2 Development Process – What Can Possibly Go Wrong?

Now, let us review one by one the process of information system development (analysis, design, programming, testing and implementation phases) and note the mistakes that may occur.

(a) Analysis Phase

During this phase, mistakes may occur in several forms, such as:

(i) Not enough attention is given to understanding the problem correctly.

(ii) The new system specification is produced without careful deliberation of the whole system that is in use.

(iii) The user does not give full cooperation to the project team. The team fails to collect the actual information about the problems that need to be solved because information is lacking.

(b) Design Phase

Mistakes that may occur include:

(i) The end user is not involved in giving input during the design phase. Therefore the design that is produced reflects the view of the technical worker.

(ii) The design does not suit the structure, culture as well as the activities of the organisation and it may not follow the priorities of the management.

(iii) Another situation that may occur is a weak design which means that the design produced is not prepared for future use, and it may be developed simply to fulfil current needs.

(iv) Failure to prepare the complete design documentation of the functions that have been built.

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(c) **Programming Phase**

The mistakes that may occur are:

(i) Lack of time estimated and the cost that is needed to develop the system.

(ii) The programmers are at times not given the full specifications.

(iii) The written program may be difficult to modify or maintain because it does not fully utilise the benefits provided in the structured programming technique or the object oriented programming technique.

(iv) The program documentation prepared is not comprehensive.

(d) **Testing Phase**

The mistakes that may occur include:

(i) The project team does not formulate an organised testing plan.

(ii) The estimation of cost and time that is allocated to testing is not sufficient.

(iii) The user is not sufficiently involved.

(e) **Implementation Phase**

The mistakes that may occur include:

(i) The system documentation and user documentation are incomplete.

(ii) The maintenance of the system is inadequate.

(iii) Evaluation of the system's achievement is not performed.

(iv) Owing to the pressures of the allocated cost and time, the system that is produced is used straight away even though it may not be completed fully.



SELF-CHECK 12.2

Discuss in detail the four factors that have an effect on the success of an information system implementation.

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12.3 MANAGING INFORMATION SYSTEM IMPLEMENTATION

As clarified previously, the failure of information systems can occur because of failure in the information system management. After understanding the factors of the success and failure, we will look at the aspect of information system management.

12.3.1 Controlling Risk Factors

All implemented projects cannot avoid from facing risks, whether big or small. In the case of information system implementation, we can use appropriate strategies to minimise the level of risk faced.

Some of the strategies are the use of the correct project management techniques adapted according to the project to be implemented. In general, we can categorise these project management techniques into three types, as summarised in Figure 12.3.

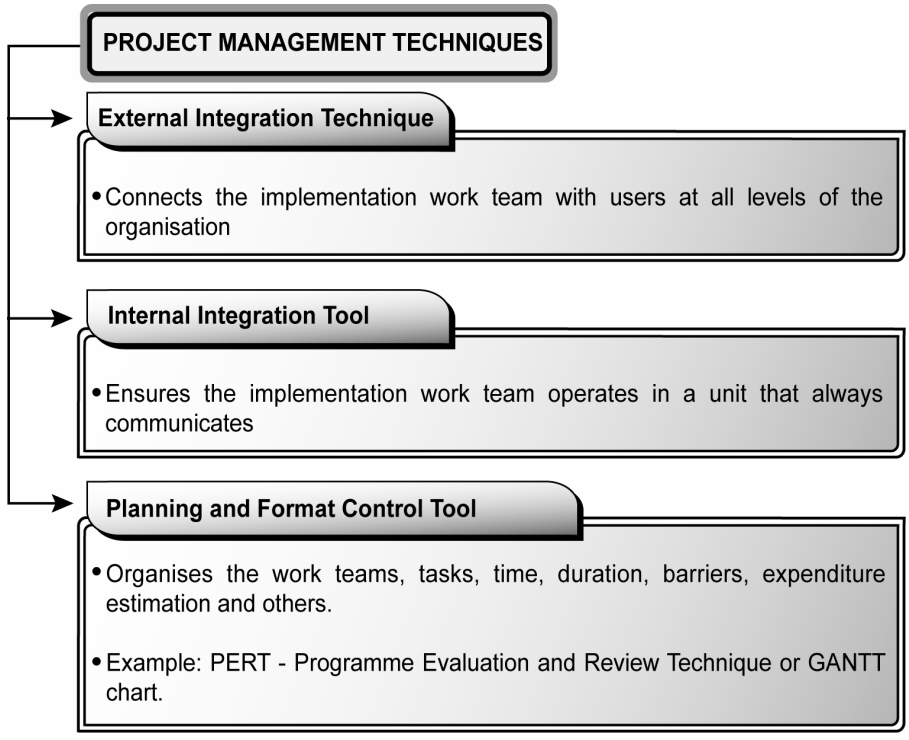


Figure 12.3: Project management techniques

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One important strategy is to ensure that there is a high level of user acceptance of the system. Many studies have been conducted on the attitudes of people in general towards accepting any changes. The management should not be tight fisted in paying the estimated cost to address this issue. Activities like training for the user, user education, improving the quality of the user interface, and encouraging the involvement of the user can be performed to 'tame' the user.

12.3.2 Strategies for Overcoming the Mistakes in Development Process

From the perspective of the overall design, we should recall the tremendous effect of the introduction of information technology in the organisation. It is important for the system designer to give full attention to the overall needs of the organisation in the production of the design. Some examples include the involvement and cooperation of workers, work design, monitoring of standards and performance, ergonomic perspective (interaction between man and machine in the work environment, including work design, health issues and user interface), procedures to overcome user resistance, health and safety, and conformity with government requirements.

It will be more beneficial if the designers can produce an information system that can integrate the technical expertise while considering the needs of the organisation and those of the workers.

SUMMARY

- In developing information systems, problems may emerge in either the development stage or system management.
- It is important to begin the system development with a clear understanding of the requirements of the system and the allowance of sufficient time to meet those requirements.
- Once the system is implemented or deployed, the evaluation of the success or failure of the system must be performed to identify any improvements that need to be made.
- The criteria of a success system are high level of usage, users satisfaction with the system, positive attitude towards the functions of the system, achievement of the system objectives, and financial returns that are obtained.

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- The reasons behind a success and a failure of information systems depend on the role of user in implementation process, the support and commitment from the management, the level of complexity and project risks, and the quality of management in implementation process.
- The most possibility of failure would be during the phases of the information system development process.
- Each phase of the information system development process has its own list of mistakes that may occur. Thus, there is a need to control these risk factors, by using the project management techniques, and to have strategies to overcome the mistakes in development process.

KEY TERMS

Controlling risk factors

External integration technique

Internal integration tool

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Answers

TOPIC 1: BUSINESS AND INFORMATION TECHNOLOGY

Self-Check 1.1

Three major changes:

1. Global economy. For example, global competition and global work groups.
2. Transformation in the economic industry. For example, competition based on shorter time and product cycle.
3. Transformation of business enterprise. For example, decentralisation and flexibility.

Self-Check 1.2

- Information – a group of arranged facts
- Process
  - Changes data into information
  - A logical set that is related to the task of achieving a result

- Knowledge
  - Rule structure, practice and procedure that are used for selecting, managing and manipulating data and making it suitable for a specific task.

Self-Check 1.3

1. (a) Accessing correct information
   (b) Accessing information at the right time
   (c) Accessing information in the required form

2. (a) Time expires
   (b) Incomplete
   (c) Not valid/true
   (d) Unknown source
   (e) Other reasons that are appropriate.

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TOPIC 2: INFORMATION TECHNOLOGY SUPPORT AND THE ORGANISATION

Self-Check 2.1

No.	Organisational Structure	Appropriateness
i.	Hierarchical Structure	• Has many layers and reflects the different powers of authority between levels. • All decisions that need to be made normally involve a process of applying to individuals at a higher level. • If there are too many levels, many processes will be delayed.
ii.	Project Based Structure	• A temporary structure that is established to handle a project. • Its temporary characteristic at times does not give enough time for the group to mature and produce the best result.
iii.	Matrix Structure	• The members consist of individuals from different groups. • Thus, it is sometimes difficult to carry out orders from two sources or from different superiors.

Self-Check 2.2

Organisational Structure	Appropriateness
• All users have equal rights from the aspect of ability to process data that they require. • Facilitates maintenance because all processing tasks are managed by the mainframe. • Other appropriate advantages.	• Unique requirements are usually difficult to fulfil because of the need to compromise with the requirements of others. • If the mainframe breaks down, all activities of other users will be disrupted. • Other appropriate disadvantages.

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TOPIC 3: INFORMATION TECHNOLOGY MANAGEMENT

Self-Check 3.1

1.
- Ensure the technology continues in a stable condition.
- Ensure the technology can be adapted to the changes that occur.

2.
- Manage information.
- Manage information technology infrastructure.
- Manage knowledge workers.

3.
- Application system development management.
- Information system development management.
- Information technology infrastructure management.
- User service administration.

4. (a) Application service provider (ASP) that usually focuses on the service needs of a company with regard to software including databases, company resource planning and customer relations.

(b) Business service provider (BSP) that develops internet software which provides software for using the internet that can be bought through web technology.

(c) Internet service provider (ISP) is a company that provides a service to connect the customers to the internet and related services.

(d) Wholesale service provider (WSP) provides grouped application packages that are distributed through the internet.

TOPIC 4: SECURITY, ETHICAL AND SOCIAL ISSUES

Self-Check 4.1

Action that being done unintentionally. Non-intentional threats include:

(i) Errors in entering the data into the technology.

(ii) Bugs on errors in programming. For example, 2/3 of the telecommunications technology in Singapore was paralysed in 1994 when new software was introduced because the software contained many bugs that had not been detected.

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(iii) Mistakes in managing files that could occur in many ways, such as accidentally deleting files, accidentally formatting the disk containing the file, or keeping the file under a name that cannot be found.

Self-Check 4.2

1. (a) Computer hacking.
   (b) Cyber theft.
   (c) Trap door.
   (d) Theft of time and computer resource.
   (e) Software piracy.
   (f) Computer virus and other damaging software.

2. (a) A virus is a piece of software that is secretly inserted into an information technology.
   (b) A worm is a piece of software that copies itself instantly and enters an information technology unit in the internet or computer network.

3. (a) Trap Door
      (i) This is a technique that enables an intrusion into a programming code using a certain information technology technique and secret codes can be inserted into the programming so that secret and invisible work can be performed by the trespasser.
      (ii) This software usually sends certain information to the trespasser that uses special signals from within the code that has been invaded.
   (b) Trojan Horse
      (i) Illegal software that is secretly absorbed into another software application that is being used by the user.
      (ii) Will "sleep" until a certain amount of time passes, whereupon it will perform the damaging actions when triggered by a certain event or time period.

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Self-Check 4.3

1. (a) Access control – controls the access to the information system through firewall, antivirus software.

   (b) Security code – password, smart card, use of the physical characteristics of the user.

   (c) Fault tolerant system.

   (d) Use of back-up.

   (e) Audits.

2. (a) Encryption

   (b) Authentication

   (c) Information integrity
   - digital signature
   - digital certificate
   - secure electronic transaction (SET)
   - electronic cash

TOPIC 5: HARDWARE

Self-Check 5.1

Primary storage or memory is kept in a computer unit at all times. It has only a temporary characteristic which means that its contents exist only when electrical current flows through it. It is used for managing data processing in the computer. The larger the memory space, the greater the amount of data that can be processed at any one time. The price of the computer also depends on the size of its memory. Examples of primary storage – RAM, ROM.

However, secondary storage is characteristically permanent. It stores output that is produced by various processes performed by the computer from time to time. The stored information will be used in the future. Examples of secondary storage – diskette, hard disk, magnetic disk, tape.

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Self-Check 5.2

The basic unit can be listed as follows:

Basic Unit	Measurement
Bit	1 or 0
Byte (Byte)	8 bits
Kilobyte (Kb)	2^{10} bytes 1024 bytes
Megabyte (Mb)	2^{10} Kb (million bytes)
Gigabyte (Gb)	2^{10} Mb (billion bytes)
Terabyte (Tb)	2^{10} Gb (trillion bytes)

A computer can understand only two values, which are 0 and 1. Therefore, any data that has to be processed by the computer must be transformed into the form of 1s and 0s, which is also known as the binary system.

Machine language uses only two symbols only in representing data or instructions from the user. These symbols, which are 1 and 0, are called bits in computer language. The machine languages used by different computers are different from one another.

Examples of Computer Instructions in Machine Language for Some Processes

Symbolic Instruction	Instruction In Machine Language (Binary)		
MOV AX,X	10111000	00001111	00000001
ADD AX,Y	00000101	00000000	00010000
SUB AX,Z	00000101	00000000	00100100
MOV K, AX	10100011	00000001	00010100
INT 20	11001101	00100000	

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Self-Check 5.3

Categories of Input Devices

Type	Use
Keyboard	Type of device for entering data by typing
Mouse (wired, infra red, track ball, touch pad)	Type of device for entering data by selecting
Joystick	Normally used for computer games. It enables graphics on the computer to be manipulated more flexibly than with the keyboard. It is in the form of a car gear stick that can rotate 360˚.
Touch screen	Enables the user to interact with the computer by touching the screen.
Optical scanner	Translates the image and character into a digital form.
Digital device	In the form of a pen that changes an image into a digital form for saving to the computer storage.
OCR (Optical Character Recognition)	Keeps the character and its format
POS (Point of Sale)	A terminal that is normally used in supermarkets that receives data while a transaction is being performed. Normally equipped with a touch screen and software that is specifically built to suit the type of transaction performed.
BCR (Bar Code Reader)	A bar code reader identifies the products in a shop, factory or warehouse through a striped label stuck to the products.
MICR (Magnetic Ink Character Recognition)	Specially created to identify the name of a bank, account number, and the amount that is displayed on the cheque. Detects input through the use of a pen – signs using a digital based-pen input.
Digital camera	Enables pictures to be captured in a digital form to be kept in the computer storage.
Terminal	The device that receives input that is sent to the mainframe computer or a mini computer that can process this input.
Voice input device	Converts the words that are voiced into digital form.
Sensor	Collects data from the environment and converts it into computer input (example: thermometers-temperature, pressure gauge).
Camera, tape recorder	Enables a voice or image to be inserted into a computer for software use or multimedia presentation.
Microphone	Acts as an input device used for voice recognition software.

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Categories of Output Peripherals

Type of Output	Use
CRT (cathode ray tube)	Computer screen display device
Plotter	Used to produce specific outputs for work normally related to engineering and architectural drawings
Printer	A device that enables the output to be printed on paper
Voice output device	Produces a voice output
LCD (liquid crystal display)	Projects the output onto a screen
COM (Computer Output Microfilm)	

TOPIC 6: SOFTWARE

Self-Check 6.1

1. Computer software can be defined as the combination of several programs that are closely linked to perform certain functions desired by its developer. Computer programs are basically the implementation of algorithms or logical steps that are used to perform a certain operation. They can be saved into many types of media like the hard disk and floppy disk, but basically software consists of instructions contained in storage media, and not the actual storage device itself.

2. (a) Buying illegal software – software piracy

   (b) Buying expensive software because it has many functions but of which only a small number are used.

   - Obtaining a new version of the software – need to absorb the new cost but this does not guarantee that it will benefit the whole organisation.
   - Maintain the older version – a possibility that the organisation would be left behind and lose out to competition.

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Self-Check 6.2

1. The three main functions of operating systems are:

   (a) Act as a user (software application) interface with the computer system.

   (b) Manage computer resources.

   (c) Manage data access.

2. A file system that is developed based on the physical arrangement of files and from there, more characteristics that cannot be provided by the physical arrangement of files are added. This is what is meant by added value to the file system.

   When a software application is executed, in reality, the instructions or programme code for that software is translated, compiled and its operations executed by the computer processor with the help of other components like memory, registers and computer clock.

Self-Check 6.3

1. Specialised software – it is designed to fulfil specific needs like the requirements in the field of engineering where AUTOCAD/CAM is specially designed to help the engineers to design related products using a computer.

   General software is designed for general use, like a word processor, e.g. Microsoft Word.

2. This is because specific software applications are developed to fulfil the specific needs of the user. For this reason, the software is designed closely following the requirements of the user. General software applications are designed for commercial use for as many users as possible in order to fulfil as many customer needs as possible. Therefore, they may not be able to fulfil the specific needs of certain individuals.

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TOPIC 7: DATABASE

Self-Check 7.1

A data hierarchy is the arrangement of data according to the size of the data from the aspect of the size of the space required to store the data. In ascending order, the hierarchy would be bit, byte, field, record, file, and finally, database.

Self-Check 7.2

1. Sequential, random and indexed.
2. It has direct access, that is, if it is kept in sequence, it can be accessed in sequence, but if it is kept randomly, then it can be accessed randomly.

Self-Check 7.3

Advantages
The traditional filing system is safe from loss of data or blocked data access owing to computer system breakdown as well as safe from electronic attacks on the data.

Disadvantages
The problem of an overlap of data causing the **integrity/validity of data** such as **inflexibility, low level of security and no sharing of data**.

Self-Check 7.4

(a) **Content** (what data should be collected?)

(b) **Access** (what data can only be accessed by users?)

(c) **Logical structure** (how should the data be arranged so that it can be easily understood by the user?)

(d) **Physical arrangement** (where will the data be stored?)

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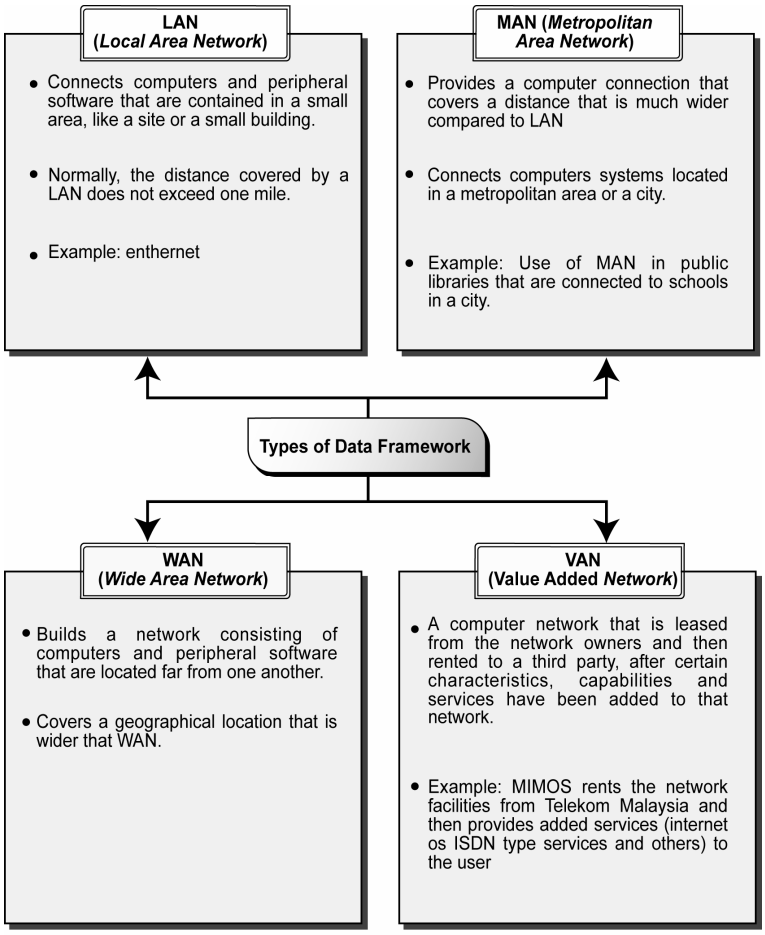
TOPIC 8: TELECOMMUNICATIONS AND NETWORK

Self-Check 8.1

Telecommunications is the channelling of data or information that uses media based on electronics for a certain distance. There are now advanced technologies like video-telephone, teleconference, telex, telegram and fax. Today's telecommunications technology not only channels data to a destination; it is also equipped with other characteristics that make data channelling easier and more effective for the user.

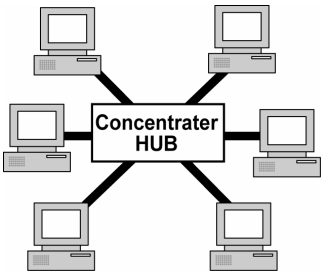
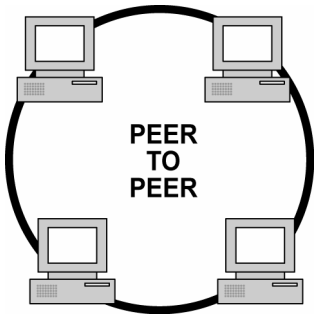
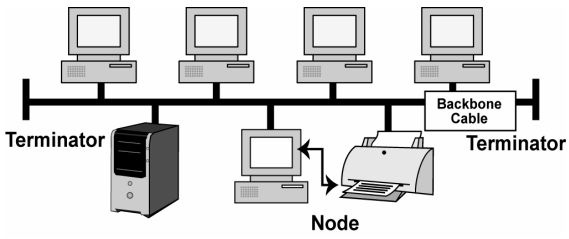
Self-Check 8.2

For connecting close distances, a local area network (LAN) is used. For longer distances, a metropolitan area network (MAN) or a wide area network (WAN) is used.



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Self-Check 8.3

(a) **Star Network** • A form of centralised arrangement where the computer host or hub device plays the role of a connector located at the centre of the connection.	
(b) **Ring Network** • Joins each available node to its neighbour until a ring or a circular shape is formed.	
(c) **Bus Network** • Uses a shared distribution line as the communication channel joining all systems connected to that line. • Illustrated as a road system that connects all nodes (computers and peripherals) to a main road.	

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Self-Check 8.4

The main characteristics of communication media are:

(a) **Speed of transmission**
This is determined by the number of bits that can be transported through the media in a second. So, the total amount of information that can be sent by any communication channel is measured in bits per second (bps). For larger measurements, kilobits per second (kbps), megabits per second (Mbps), or gigabits per second (Gbps) are used.

The term bandwidth is often used to describe the rate of speed in sending data through a type of media. Bps is also a unit that is used to describe the speed of this bandwidth. What is the connection? Actually, the term bandwidth refers to the channel capacity of the transport media. Generally, the bigger the bandwidth, the higher the transmission speed.

(b) **Noise resistance rate**
The transport media that carries the data is actually carrying electrical current or a wave that represents the data to be moved. The original form of this electrical current or wave can change owing to external influences. For example, electrical current in a transmission cable can change when there is another transmission cable located in close proximity which has electrical current flowing through it. This disturbance is called noise. Some transmissions are susceptible to noise, while others are noise proof.

(c) **Cost**
Some transmission media are more expensive than others. Some are not only expensive with regard to cost per unit, but their installation costs are higher than other media.

(d) **Transmission mode**
In a telecommunications network, there has to be a certain type of transmission, which is **asynchronous** or **synchronous** transmission. Try and guess what is meant by asynchronous and synchronous transmission. Actually, two computers that are connected are said to use synchronous transmission if both are ready to send and receive data at the same time. This synchronous transmission can be achieved by using the same timing system. If the time of sending and receiving is not controlled by the same timing system, it is said not to be synchronous. Normally, asynchronous transmission is transmission at a lower speed where a character is sent at a time, while synchronous transmission is the transmission of a group of characters at one time at high speed.

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(e) **Direction of transmission**
There are three types, which are **simplex**, **half-duplex** and **full-duplex** forms. The simplex direction of transmission allows the transmission of data in one direction at any one time in the transmission media. Half-duplex is when data transmission is permitted in both directions, but only one direction is allowed at any one time. On the other hand, full-duplex refers to the transmission of data in both directions at the same time.

Self-Check 8.5

The Internet is the abbreviated form of "international networking" or a network to millions of smaller networks located all over the world. It is the largest type of global network and offers many services like electronic mail, file transfer and group work that is managed by many parties that work together to manage its operations.

TOPIC 9: FUNCTIONAL INFORMATION SYSTEMS AND DECISION SUPPORT SYSTEMS

Self-Check 9.1

(a) Information System for Operational Support

(b) Information System for Strategic Management and Tactical Management Support

(c) Management Information System (MIS)

(d) Artificial Intelligence Based System

(e) Intergrated Information System

Self-Check 9.2

The main objective of TPS is to make available the required information so that organisational operations can be implemented effectively and properly. Other objectives include:

- Enabling the organisation to operate efficiently and effectively.
- Preparing reports and documents on time.
- Increasing the competitive advantage of the organisation.
- Making available accurate data for the strategic and tactical systems, for example data for the management information system (MIS) and decision support system (DSS).
- Ensuring the accuracy and reliability of the data and information.

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- Controlling the security of the data and information.
- Helping maintain user/customer loyalty.

Self-Check 9.3

1. A management information system (MIS) is the original information system that has long been developed with the aim of supplying information to assist the manager in carrying out the various daily activities so that the process of planning, controlling and monitoring can be implemented more efficiently and effectively.

2. The output is a collection of reports that are distributed to the managers. These reports are divided into three main categories, which are:

   (a) **Periodical Report**

   - Produced after a certain amount of time or periodically, such as daily, weekly or monthly.
   - Example: monthly departmental report.

   (b) **Requested Reports**

   - Produced when requested by superiors or customers.
   - Example: reports that are requested by the departmental manager on the number of working hours of a certain employee in that week.

   (c) **Unexpected Reports**

   - Produced automatically upon the occurrence of an unexpected event that rarely or never happens, which requires the management to act.

3. Prepares reports using a specific and uniform format. For example, a periodical financial report will have the same fields and types of data at the same locations for every report.

   - Prepares reports in soft copy or hard copy. The report can be printed on paper (hard copy) or it can be read directly from the computer screen. Regardless of the format, the report is the same.
   - Uses internal and external data. Most MIS applications use internal data from the organisational database, though external data is also used.
   - Usually, the input for MIS is the result of the TPS.

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- Enables the end user to produce reports that he requires. It may need the production of certain programs with the help of a programmer.
- Is able to prepare information for the use of strategic and tactical managers.

TOPIC 10: REDESIGNING THE ORGANISATION WITH INFORMATION SYSTEMS

Self-Check 10.1

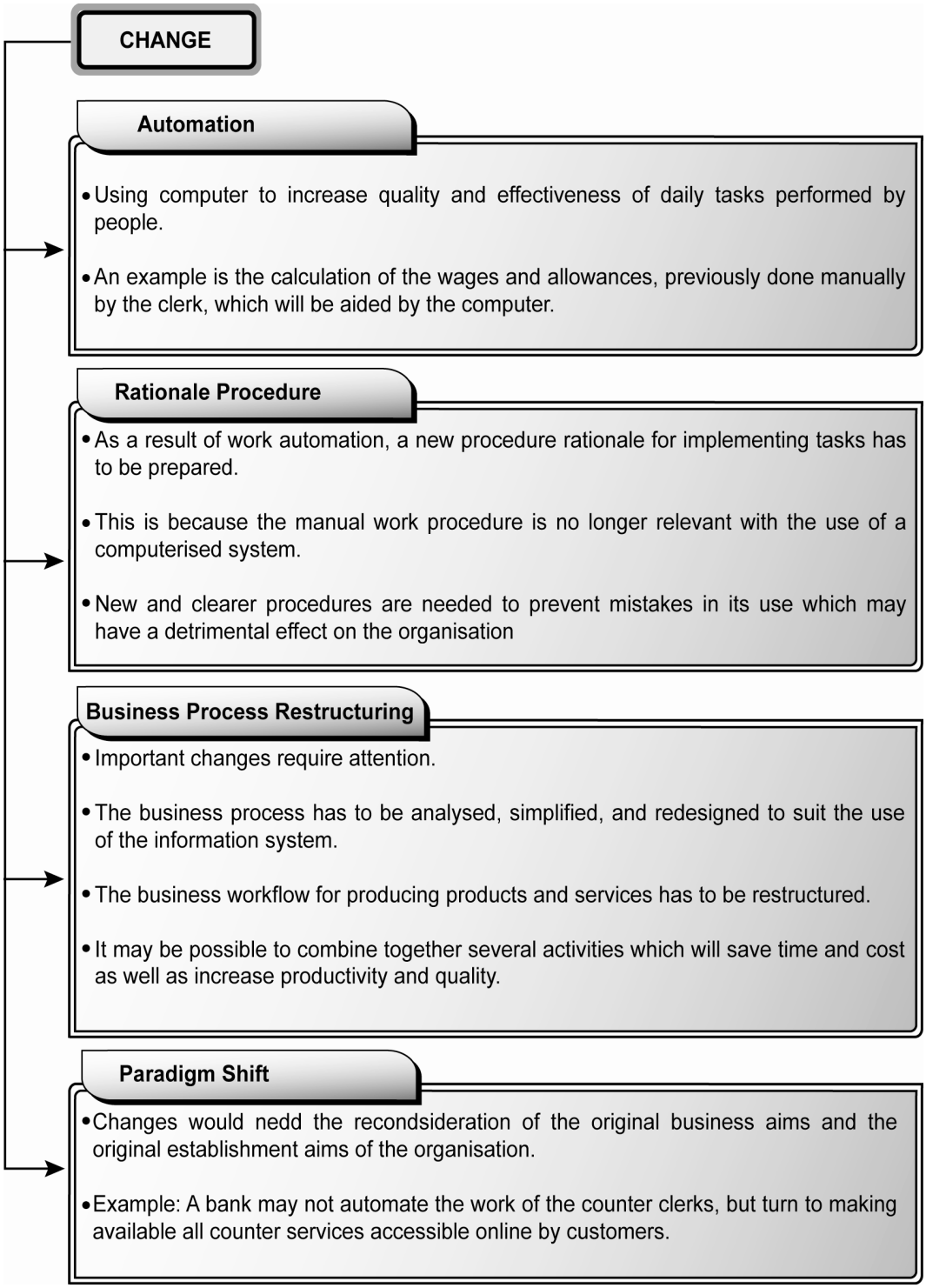
1. (a) **Structured Problem**
   - Easy to understand and can be solved by performing several organised steps.
   - If the same problem recurs in the future, perhaps similar steps can be taken to solve it.
   - Example: the number of workers needed to complete project A within a month.

   (b) **Non-structured Problem**
   - There is no certain outcome to solve it.
   - It is possibly caused by lack of information or the existence of too many factors that may complicate matters to the extent there is no single formula that can guarantee the best solution.
   - Normally difficult to understand.
   - Example: the problem of envious workers.

   (c) **Semi-structured Problem**
   - Combination of structured and non-structured problems.
   - Parts of the elements are easy to understand and other parts are difficult to understand.
   - Example: selection of an investment company or selection of a promotion or new product. The related information regarding the company for investment may be easy to obtain, but a forecast whether the company will experience profit or loss will be difficult to do.

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2.



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TOPIC 11: METHODS FOR SYSTEM DEVELOPMENT AND ALTERNATIVE METHODS FOR SYSTEM DEVELOPMENT

Self-Check 11.1

1. The analysis phase will only be performed after agreement is achieved with regard to the development of a new system during the investigation phase. In this phase, a study is performed to understand the business problem that the organisation plans to solve using an information system.

2. System design is divided into two parts, which are the logical system design and physical system design.

Design Specifications for Logical and Physical System Designs

Logical System Design Specifications	Physical System Design Specifications
Explains the work that the system will perform.	Explains the function that the system will perform.
Abstract type specification.	Actual physical type specification.
Includes the designs for input, output, process, database, telecommunications, control, security and tasks of the information system.	Includes the design of hardware, software, database, telecommunications and procedure.

3. The information that is obtained from this phase is:
   (i) Strengths and weaknesses of the existing system.
   (ii) Functions that must be in the new system to solve problems.
   (iii) Information regarding user requirements for the new system.

4. The final result of the programming phase is the completed system program.

Self-Check 11.2

1. (a) Synchronous Conversion
   (b) Direct Conversion
   (c) Pilot Conversion
   (d) Conversion in stages

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2. The process of maintenance has to be performed to ensure that no major problems occur during the life time of the system. Maintenance is carried out by re-testing the program and modifying the system so that it is in line with the changes that occur in the organisation or business. This process is made without adding to the functions of the system.
   There are also maintenance procedures to be added to the system functions. This process is performed to add new features without disrupting the operation of the system.

Self-Check 11.3

1. The prototype model is normally used when the user requirements are difficult to obtain during the early stages of system development. The developer of the system will develop a prototype to give a demonstration of the actual system to the user. The user can make comments and give suggestions of the model so that it meets his requirements. The system developer will then modify or adjust the system to reflect these requirements. This is an ongoing process until the user agrees to the characteristics of the system or cancels it.

2. Since the model prototype combines the analysis and design phases, there is a possibility that the system analyst may provide incorrect information in the documentation to the programmer. This may give rise to problems in the implementation and maintenance phases.

3. Joint Application Design (JAD) is a method of gathering information relating to user needs and system design in the SDLC phase that is performed as a group.

   The system analyst will hold a meeting for all individuals involved in the system that will be developed. Discussions relating to the requirements of the new system will be held and all parties have the right to voice their opinions. An agreement regarding the system requirements will be formulated at the end of the discussion.

4. The disadvantages of using JAD are as follows:

   (a) Difficult to gather all users at one time, especially in a large organisation.

   (b) The possibility that several parties will control the meeting while some parties are too shy to voice their opinions.

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Self-Check 11.4

1. Rapid Application Development (RAD) combines the JAD development method, prototyping and CASE tools to produce a high quality system. In the early stages, the JAD method was used to collect the user requirement information. Then, the CASE tools were used to develop a prototype model. The prototype model would be presented to the user in a JAD session for the users comments and views.

2. The disadvantages of using RAD are as follows:

   (a) The functions and comprehensiveness of the system may be limited because of the time factor.

   (b) The system is difficult to modify according to changes within the organisation.

   (c) There is a possibility that certain processes are not documented or poorly documented.

3. The development of a system using the SDLC method requires that we follow certain steps or phases that have been established. A system that is developed using the SDLC is normally suitable for certain types of problems only. Even though it may involve the same database, with the emergence of different problems, other systems may have to be developed to solve them. For example, a system for the salary payment of workers cannot be modified to become a system to record workers' leave.

4. The advantages of using an object oriented development method are:

   (a) Reduces the complexity of development of a system and facilitates maintenance because each object is normally small and easy to manage.

   (b) Increases productivity and quality of programming because when an object has been built and has gone through the processes of testing and deployment, it can be reused in other systems.

   (c) The system that is built is more flexible. Modifications can be made by changing certain objects.

   (d) It is very suitable for developing web based systems.

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Self-Check 11.5

1. Can be summarised as buying a product or obtaining a service from an external organisation.

2. The need for using information technology in the organisation today is increasingly pertinent. However, not all organisations have their own information technology department that can develop and maintain the organisational information system. Because of the need for an information system, an organisation may appoint a third party to develop the system which can fulfil the business needs. This method of system development is known as development by a third party or outsourcing.

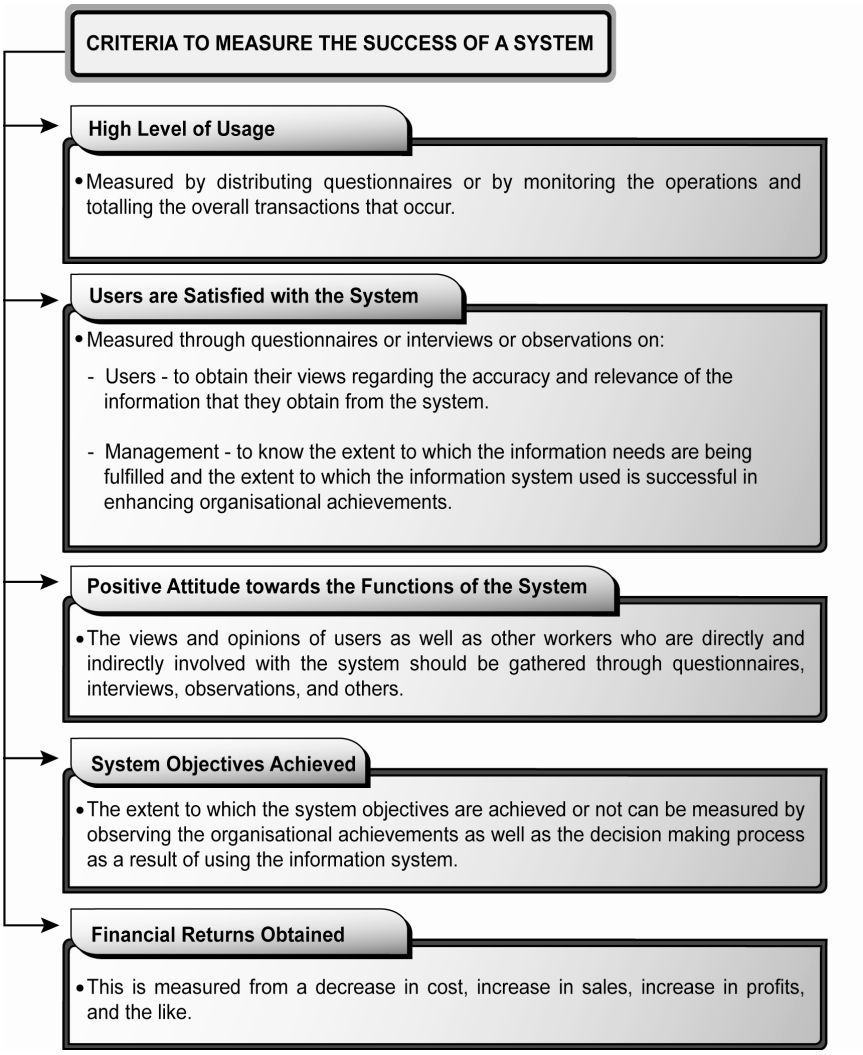
   Examples:

   - Purchase of computer hardware, office furniture and others from other organisations.
   - Even though hardware and furniture are bought from outside organisation, they must fulfil the needs of the organisation according to the standards that have been established.
   - Information system development.

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TOPIC 12: SUCCESS AND FAILURE OF INFORMATION SYSTEM IMPLEMENTATION

Self-Check 12.1



Self-Check 12.2

(a) Role of the user;

(b) Support and commitment of the management;

(c) Management quality; and

(d) Level of complexity and project risk.

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