MANAGEMENT INFORMATION SYSTEMS

INSTRUCTIONS: While the notes and questions below encompass the totality of information systems, concentrate on questions relating to

- **Information systems (in general)**
- **Management Information Systems (MIS)**
- **System Development Life Cycle (Waterfall model)**

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1. Introduction

An information system is a set of interrelated components that collect, manipulate, process and transform data into information and provide feedback to meet a specified objective. A computer based information system is an information system that uses computer technology to perform input, processing and output activities. Due to the massive computerization of manual information systems, computer based information systems are simply referred to as information systems. They are the subject of discussion in this chapter.

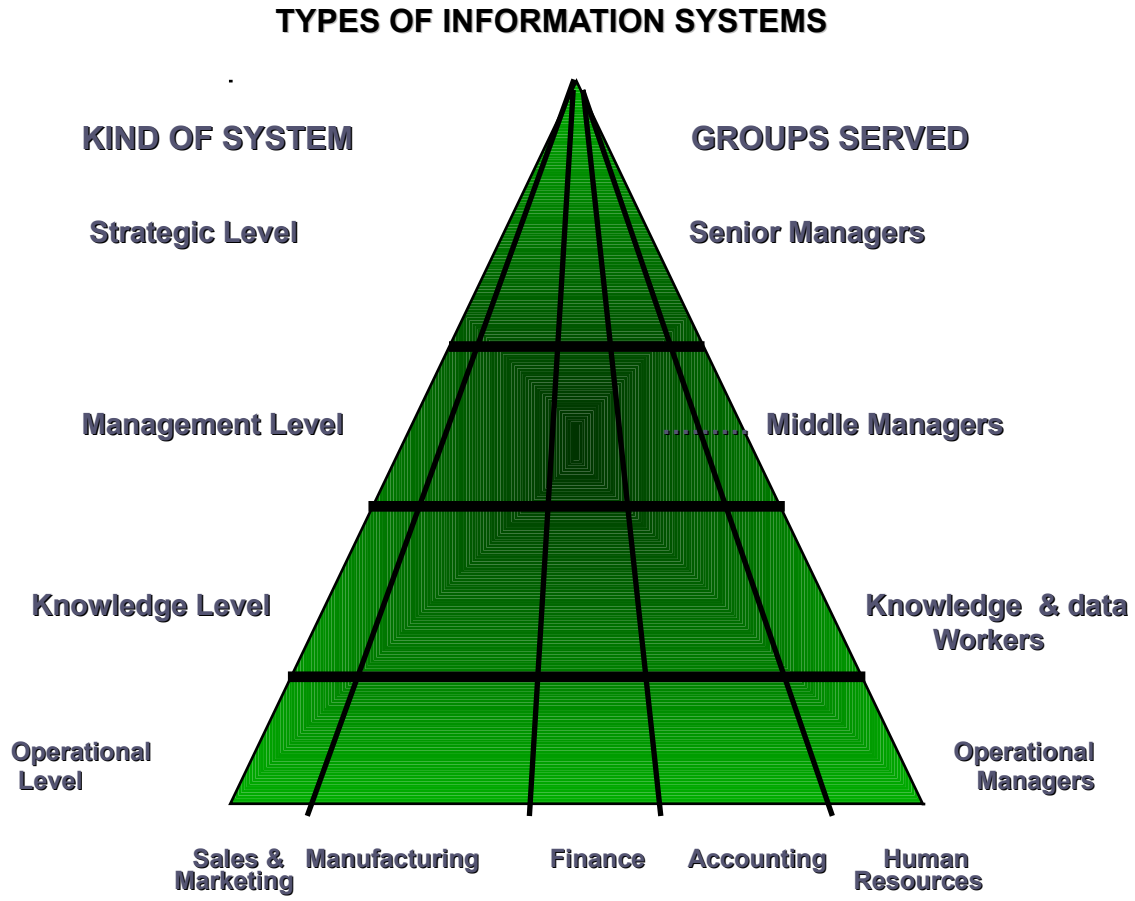
Common examples of information systems include: Automated Teller Machines (ATMs), Point of Sale (POS) terminals used by supermarket checkout clerks, airline reservation systems or flight schedule systems used by airlines, student registration systems used by colleges etc.

2. Management structure and use of information

Information systems support different types of decisions at different levels of the organizational hierarchy. While operational managers mostly make structured decisions, senior managers deal with unstructured decisions and

middle managers are often faced with semi-structured decisions.

For each functional area in the organization, four levels of organizational hierarchy can be identified: the operational level, knowledge level, management level and strategic level. Different types of information systems serve each of these levels.



3. Components of an information system

Components of an information system include:

- People – These use the system to fulfil their informational needs. They include end users and operations personnel such as computer operators, systems analysts, programmers, information systems management and data administrators.

- Computer Hardware – Refers to physical computer equipment and devices, which provide for five major functions.
  - Input or data entry
  - Output
  - Secondary storage for data and programs
  - Central processor (computation, control)
  - Communication

- Computer Software – Refers to the instructions that direct the operation of the computer hardware. It is classified into system and application software.

- Telecommunication System/Communication network

- Databases – Contains all data utilized by application software. An individual set of stored data is referred to as a file. Physical storage media evidences the physical existence of stored data, that is: tapes, disk packs, cartridges, and diskettes.

- Procedures – Formal operating procedures are components because they exist in physical forms as manuals or instruction booklets. Three major types of procedures are required.

    - User instructions – for application users to record data, to use a terminal for data entry or retrieval, or use the result.
    - Instructions for preparation of input by data preparation personnel.
    - Operating instructions for computer operations personnel.

4. Functions of an information system

The functions of an information system can be generally classified into those functions involved in:

- Transaction processing
- Management reporting
- Decision support

4.1 Transaction processing

Major processing functions include:

i. Process transactions – Activities such as making a purchase or a sale or manufacturing a product. It may be internal to the organization or involve an external entity. Performance of a transaction requires records to:

    - Direct a transaction to take place
    - Report, confirm or explain its performance
    - Convey it to those needing a record for background information or reference.

ii. Maintain master files – Many processing activities require operation and maintenance of a master file, which stores relatively permanent or historical data about organizational entities. E.g. processing an employee paycheck needs data items such as rate of pay, deductions etc. transactions when processed update data items in the master file to reflect the most current information.

iii. Produce reports – reports are significant products of an information system. Scheduled reports are produced on a regular basis. An information system should also be able to produce special reports quickly based on ‘ad hoc’ or random requests.

iv. Process inquiries – Other outputs of the information system are responses to inquiries using the databases. These may be regular or ad hoc inquiries. Essentially inquiry processing should make any record or item in the database easily accessible to authorized personnel.

v. Process interactive support applications – The information system contains applications to support systems for planning, analysis and decision making. The mode of operation is interactive, with the user responding to questions, requesting for data and receiving results immediately in order to alter inputs until a solution or satisfactory result is achieved.

4.2 Management reporting

This is the function involved in producing outputs for users. These outputs are mainly as reports to management for planning, control and monitoring purposes. Major outputs of an information system include:

i. Transaction documents or screens
ii. Preplanned reports
iii. Preplanned inquiry responses
iv. Ad hoc reports and ad hoc inquiry responses
v. User-machine dialog results

4.3 Decision support

Types of decisions

a) Structured/programmable decisions

These decisions tend to be repetitive and well defined e.g. inventory replenishment decisions. A standardized pre-planned or pre-specified approach is used to make the decision and a specific methodology is applied routinely. Also the type of information needed to make the decision is known precisely. They are programmable in the sense that unambiguous rules or procedures can be specified in advance. These may be a set of steps, flowchart, decision table or formula on how to make the decision. The decision procedure specifies information to be obtained before the decision rules are applied. They can be handled by low-level personnel and may be completely automated.

It is easy to provide information systems support for these types of decisions. Many structured decisions can be made by the system itself e.g. rejecting a customer order if the customer's credit with the company is less than the total payment for the order. Yet managers must be able to override these systems' decisions because managers have information that the system doesn't have e.g. the customer order is not rejected because alternative payment arrangements have been made with the customer.

In other cases the system may make only part of the decision required for a particular activity e.g. it may determine the quantities of each inventory item to be reordered, but the manager may select the most appropriate vendor for the item on the basis of delivery lead time, quality and price.

Examples of such decisions include: inventory reorder formulas and rules for granting credit. Information systems requirements include:

- Clear and unambiguous procedures for data input
- Validation procedures to ensure correct and complete input
- Processing input using decision logic
- Presentation of output so as to facilitate action

b) Semi-structured/semi-programmable decisions

The information requirements and the methodology to be applied are often known, but some aspects of the decision still rely on the manager: e.g. selecting the location to build a new warehouse. Here the information requirements for the decision such as land cost, shipping costs are known, but aspects such as local labour attitudes or natural hazards still have to be judged and evaluated by the manager.

c) Unstructured/non-programmable decisions

These decisions tend to be unique e.g. policy formulation for the allocation of resources. The information needed for decision-making is unpredictable and no fixed methodology exists. Multiple alternatives are involved and the decision variables as well as their relationships are too many and/or too complex to fully specify. Therefore, the manager's experience and intuition play a large part in making the decision.

In addition there are no pre-established decision procedures either because:

- The decision is too infrequent to justify organizational preparation cost of procedure or
- The decision process is not understood well enough, or
- The decision process is too dynamic to allow a stable pre-established decision procedure.

Information systems requirements for support of such decisions are:

- Access to data and various analysis and decision procedures.
- Data retrieval must allow for ad hoc retrieval requests
- Interactive decision support systems with generalized inquiry and analysis capabilities.

Example: Selecting a CEO of a company.

1. Types of information systems: characteristics and differences

Major types of systems include:

1. Transaction Processing Systems (TPS)
2. Management Information Systems (MIS)
3. Decision Support Systems (DSS)
4. Executive Support Systems (ESS)
5. Expert Systems

5.1 Transaction Processing System (TPS)

A transaction is any business related exchange, such as a sale to a client or a payment to a vendor. Transaction processing systems process and record transactions as well as update records. They automate the handling of data about business activities and transactions. They record daily routine transactions such as sales orders from customers, or bank deposits and withdrawals. Although they are the oldest type of business information system around and handle routine tasks, they are critical to business organization. For example, what would happen if a bank's system that records deposits and withdrawals and maintain accounts balances disappears?

TPS are vital for the organization, as they gather all the input necessary for other types of systems. Think of how one could generate a monthly sales report for middle management or critical marketing information to senior managers without TPS. TPS provide the basic input to the company's database. A failure in TPS often means disaster for the organization. Imagine what happens when an airline reservation system fails: all operations stops and no transaction can be carried out until the system is up and running again. Long queues form in front of ATMs and tellers when a bank's TPS crashes.

Transaction processing systems were created to maintain records and do simple calculations faster, more accurately and more cheaply than people could do the tasks.

Characteristics of TPS:

- TPS are large and complex in terms of the number of system interfaces with the various users and databases and usually developed by MIS experts.
- TPS's control collection of specific data in specific formats and in accordance with rules, policies, and goals of organisation- standard format

- They accumulate information from internal operations of the business.
- They are general in nature—applied across organisations.
- They are continuously evolving.

The goals of TPS is improve transaction handling by:

- Speeding it up
- Using fewer people
- Improving efficiency and accuracy
- Integrating with other organizational information systems
- Providing information that was not available previously

Examples—Airline reservation systems, Automated Teller Machines (ATMs,) order processing systems, registration systems, Payroll systems and point of sale systems.

5.2 **Management Reporting/Information System (MRS/MIS)**

Management Reporting Systems (**MRS)** formerly called ***Management information systems (MIS)*** provide routine information to decision makers to make structured, recurring and routine decisions, such as restocking decisions or bonus awards. They focus on operational efficiency and provide summaries of data. A MRS takes the relatively raw data available through a TPS and converts it into meaningful aggregated form that managers need to conduct their responsibilities. They generate information for monitoring performance (e.g. productivity information) and maintaining coordination (e.g. between purchasing and accounts payable).

The main input to an MRS is data collected and stored by transaction processing systems. A MRS further processes transaction data to produce information useful for specific purposes. Generally, all MIS output have been pre-programmed by information systems personnel. Outputs include:

a) Scheduled Reports – These were originally the only reports provided by early management information systems. Scheduled reports are produced periodically, such as hourly, daily, weekly or monthly. An example might be a weekly sales report that a store manager gets each Monday showing total weekly sales for each department compared to sales this week last year or planned sales.
b) Demand Reports – These provide specific information upon request. For instance, if the store manager wanted to know how weekly sales were going on Friday, and not wait until the scheduled report on Monday, she could request the same report using figures for the part of the week already elapsed.
c) Exception Reports – These are produced to describe unusual circumstances. For example, the store manager might receive a report for the week if any department's sales were more than 10% below planned sales.

Characteristics of MRS

- MIS professionals usually design MRS rather than end users- using life cycle oriented development methodologies.
- They are large and complex in terms of the number of system interfaces with the various users and databases.
- MRS are built for situations in which information requirements are

reasonably well known and are expected to remain relatively stable. This limits the informational flexibility of MRS but ensures that a stable informational environment exists.

- They do not directly support the decision making process in a search for alternative solutions to problems. Information gained through MRS is used in the decision making process.
- They are oriented towards reporting on the past and the present, rather than projecting the future. Can be manipulated to do predictive reporting.
- MRS have limited analytical capabilities. They are not built around elaborate models, but rather rely on summarisation and extraction from the databases according to the given criteria.

5.3 Decision Support System (DSS)

Decision support systems provide problem-specific support for non-routine, dynamic and often complex decisions or problems. DSS users interact directly with the information systems, helping to model the problem interactively. DSS basically provide support for non-routine decisions or problems and an interactive environment in which decision makers can quickly manipulate data and models of business operations. A DSS might be used for example, to help a management team decide where to locate a new distribution facility. This is a non-routine, dynamic problem. Each time a new facility must be built, the competitive, environmental, or internal contexts are most likely different. New competitors or government regulations may need to be considered, or the facility may be needed due to a new product line or business venture.

When the structure of a problem or decision changes, or the information required to address it is different each time the decision is made, then the needed information cannot be supplied by an MIS, but must be interactively modelled using a DSS. DSS provide support for analytical work in semi-structured or unstructured situations. They enable mangers to answer ‘What if’ questions by providing powerful modelling tools (with simulation and optimization capabilities) and to evaluate alternatives e.g. evaluating alternative marketing plans.

DSS have less structure and predictable use. They are user-friendly and highly interactive. Although they use data from the TPS and MIS, they also allow the inclusion of new data, often from external sources such as current share prices or prices of competitors.

DSS components include:

a) Database (usually extracted from MIS or TPS)
b) Model Base
c) User Dialogue/Dialogue Module

5.4 Executive information system (EIS) / Executive Support Systems (ESS)

EIS provide a generalized computing and communication environment to senior managers to support strategic decisions. They draw data from the MIS and allow communication with external sources of information. But unlike DSS, they are not designed to use analytical models for specific problem solving. EIS are designed to facilitate senior managers’ access to information quickly and effectively.

ESS has menu-driven user-friendly interfaces, interactive graphics to help visualization of the situation and communication capabilities that link the senior executives to the external databases he requires.

Top executives need ESS because they are busy and want information quickly and in an easy to read form. They want to have direct access to information and want their computer set-up to directly communicate with others. They want structured forms for viewing and want summaries rather than details.

5.5 Expert System (ES)

- It is an advanced DSS that provides expert advice by asking users a sequence of questions dependent on prior answers that lead to a conclusion or recommendation. It is made of a knowledge base (database of decision rules and outcomes), inference engine (search algorithm), and a user interface.
- ES use artificial intelligence technology.
- It attempts to codify and manipulate knowledge rather than information
- ES may expand the capabilities of a DSS in support of the initial phase of the decision making process. It can assist the second (design) phase of the decision making process by suggesting alternative scenarios for "what if" evaluation.
- It assists a human in the selection of an appropriate model for the decision problem. This is an avenue for an automatic model management; the user of such a system would need less knowledge about models.
- ES can simplify model-building in particular simulation models lends itself to this approach.
- ES can provide an explanation of the result obtained with a DSS. This would be a new and important DSS capability.
- ES can act as tutors. In addition ES capabilities may be employed during DSS development; their general potential in software engineering has been recognised.

5.6 Other Information Systems

These are special purpose information systems. They are more recent types of information systems that cannot be characterized as one of the types discussed above.

(i) Office Automation Systems (OAS)

Office automation systems support general office work for handling and managing documents and facilitating communication. Text and image processing systems evolved as from word processors to desktop publishing, enabling the creation of professional documents with graphics and special layout features. Spreadsheets, presentation packages like PowerPoint, personal database systems and note-taking systems (appointment book, notepad, card file) are part of OAS.

In addition OAS include communication systems for transmitting messages and documents (e-mail) and teleconferencing capabilities.

(ii) Artificial Intelligence Systems

Artificial intelligence is a broad field of research that focuses on developing computer systems that simulate human behaviour, that is, systems with human characteristics. These characteristics include, vision, reasoning, learning and natural language processing.

Examples: Expert systems, Neural Networks, Robotics.

(iii) Knowledge Based Systems/ Knowledge Work Systems (KWS)

Knowledge Work Systems support highly skilled knowledge workers in the creation and integration of new knowledge in the company. Computer Aided Design (CAD) systems used by product designers not only allow them to easily make modifications without having to redraw the entire object (just like word processors for documents), but also enable them to test the product without having to build physical prototypes.

Architects use CAD software to create, modify, evaluate and test their designs; such systems can generate photo-realistic pictures, simulating the lighting in rooms at different times of the day, perform calculations, for instance on the amount of paint required. Surgeons use sophisticated CAD systems to design operations. Financial institutions use knowledge work systems to support trading and portfolio management with powerful high-end PCs. These allow managers to get instantaneous analysed results on huge amounts of financial data and provide access to external databases.

Workflow systems are rule-based programs - (IF 'this happens' THEN 'take this action')- that coordinate and monitor the performance of a set of interrelated tasks in a business process.

(iv) Geographic Information Systems (GIS)

Geographic information systems include digital mapping technology used to store and manipulate data relative to locations on the earth. An example is a marketing GIS database. A GIS is different from a Global Positioning System (GPS). The latter is a satellite-based system that allows accurate location determination.

(v) Virtual Reality Systems

Virtual reality systems include 3-dimensional simulation software, where often the user is immersed in a simulated environment using special hardware (such as gloves, data suits or head mounted displays). Sample applications include flight simulators, interior design or surgical training using a virtual patient.

(vi) E-Commerce/E-Business Systems

E-Commerce involves business transactions executed electronically between parties. Parties can be companies, consumers, public sector organizations or governments.

(vii) Enterprise Resource Planning (ERP) systems

ERP systems are a set of integrated programs that handle most or all organization's key business processes at all its locations in a unified manner. Different ERP packages have different scopes. They often coordinate planning, inventory control, production and ordering. Most include finance and manufacturing functions, but many are now including customer relationship management, distribution, human resource as well as supply chain management. ERP systems are integrated around a common database. Some well known ERP vendors are ORACLE, SAP and PeopleSoft.

For instance a manufacturing company may prepare a demand forecast for an item for the next month. The ERP system would then check existing items inventory to see if there is enough on hand to meet the demand. If not, the ERP system schedules production of the shortfall, ordering additional raw material and shipping materials if necessary.

(viii) Electronic Funds Transfer (EFT)

EFT is the exchange of money via telecommunications without currency actually changing hands. EFT refers to any financial transaction that transfers a sum of money from one account to another electronically. Usually, transactions originate at a computer at one institution (location) and are transmitted to a computer at another institution (location) with the monetary amount recorded in the respective organization's accounts. Because of the potential high volume of money being exchanged, these systems may be in an extremely high-risk category. Therefore, access security and authorization of processing are important controls.

Security in an EFT environment is extremely important. Security includes

methods used by the customer to gain access to the system, the communications network and the host or application-processing site. Individual customer access to the EFT system is generally controlled by a plastic card and a personal identification number (PIN). Both items are required to initiate a transaction.

(ix) Automated Teller Machine (ATM)

An ATM is a specialized form of point of sale terminal designed for the unattended use by a customer of a financial institution. These customarily allow a range of banking and debit operations, especially financial deposits and cash withdrawals. ATMs are usually located in uncontrolled areas and utilize unprotected telecommunications lines for data transmissions. Therefore the system must provide high levels of logical and physical security for both the customer and the machinery.

Recommended internal control guidelines for ATMs include the following:

- Review measures to establish proper customer identification and maintenance of their confidentiality
- Review file maintenance and retention system to trace transactions
- Review and maintain exception reports to provide an audit trail
- Review daily reconciliation of ATM machine transactions.

6. The organization of ICT department

ICT Department functions

a) Development, ongoing operation and maintenance of information systems
b) Advisor to ICT users throughout the organisation
c) Catalyst for improving operations through system enhancements/ new systems development
d) Co-ordinating systems integration in the org.
e) Establishing standards, policy, and procedures relating to ICT.
f) Evaluating and selecting hardware and software
g) Co-ordinating end-user education.

Officers in ICT department

- IT Manager/Director
- Systems analysts
- Programmers- system and applications
- Database administrator
- Network administrator
- Librarian
- Support staff- hardware, software technicians
- Data entry clerks

The number of people working in the ICT department and what they do will depend on:

- *The size of the computing facility.* Larger computers are operated on a shift work basis.
- *The nature of the work.* Batch processing systems tend to require more staff.
- *Whether a network is involved.* This requires additional staff.
- *How much software and maintenance is done in house* instead of seeking external resources.

The information technology staff may be categorized into various sections

whose managers are answerable to the information technology manager. The responsibilities of the information technology manager include:

- Giving advice to managers on all issues concerning the information technology department.
- Determining the long-term IT policy and plans of the organization.
- Liaisons with external parties like auditors and suppliers.
- Setting budgets and deadlines.
- Selecting and promoting IT staff.

Structure of ICT department

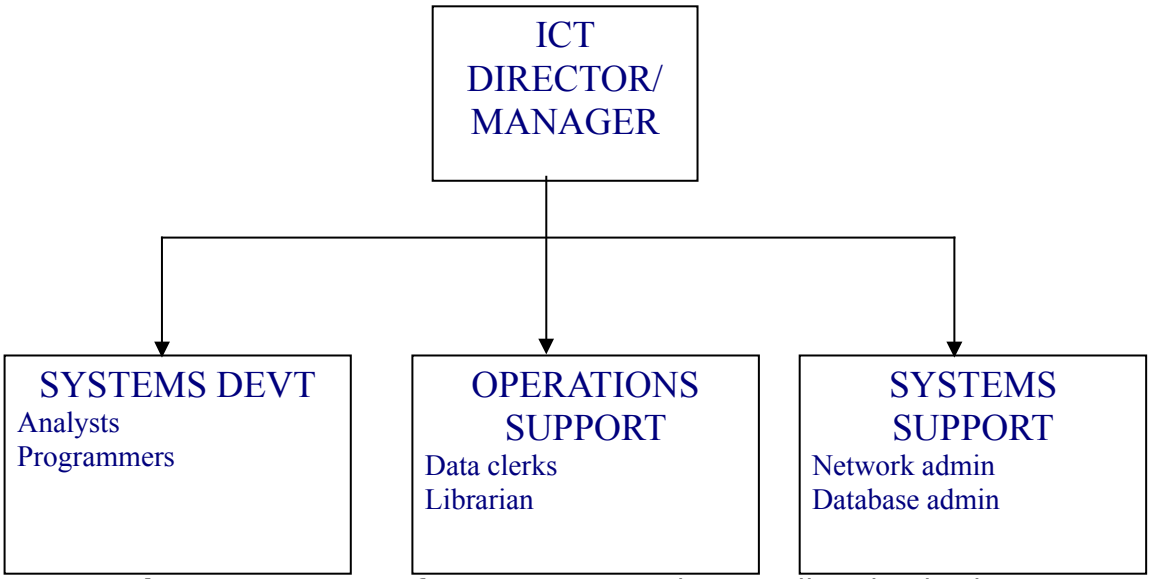
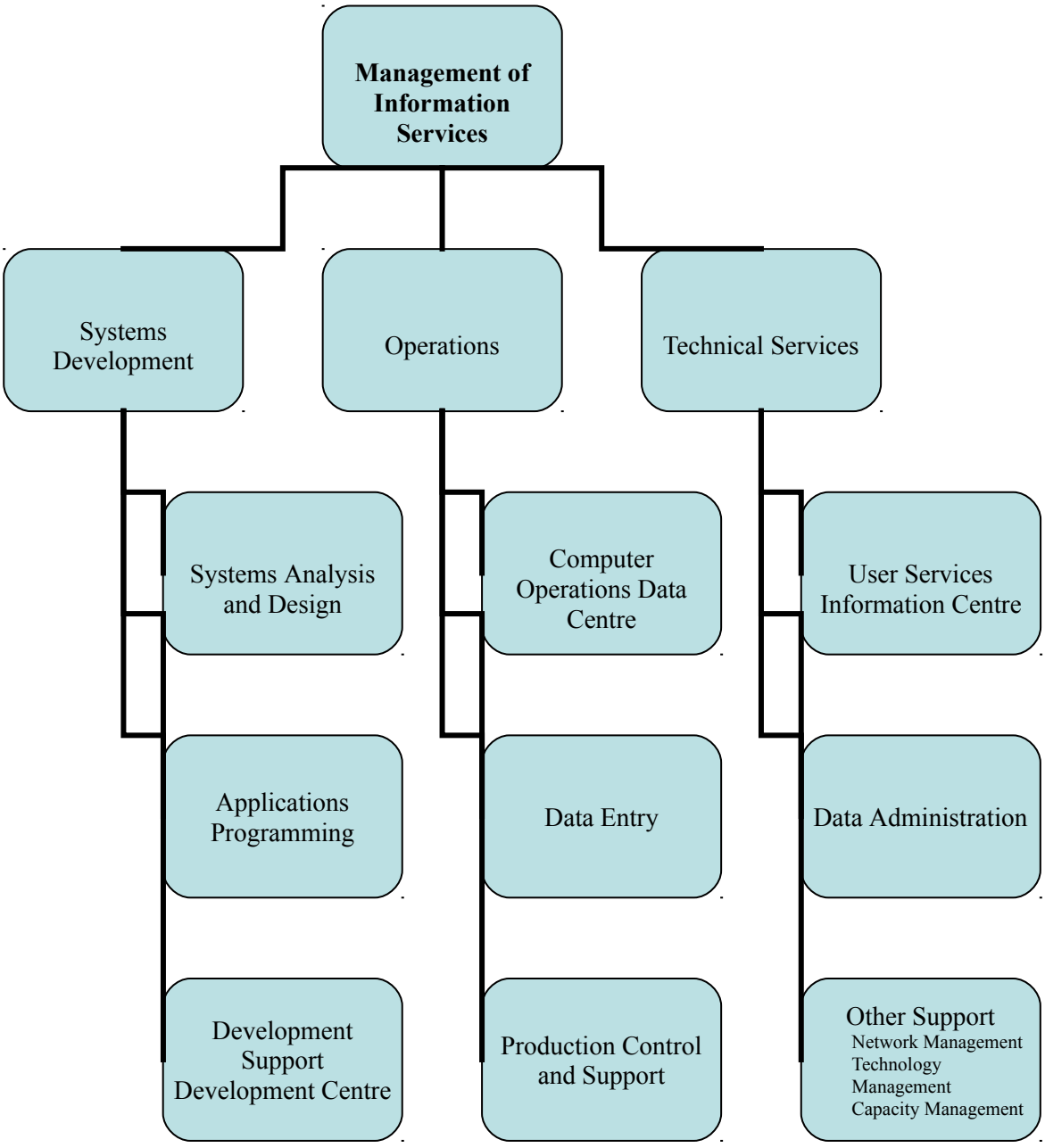


Figure: *Structure of ICT Department in a medium institution*

Functional structure for information services department



The sections that make up the ICT department and their functions are discussed below:

1) Development section
System Analysis Functions include:
- System investigations.
- System design.
- System testing.
- System implementation.
- System maintenance.

Programming Functions include:
- Writing programs.
- Testing programs.
- Maintenance of programs.
- System programmers write and maintain system software. Application programmers write programs or customize software to carry out specific tasks.

2) Operations section
Duties include:
- Planning procedures, schedules and staff timetables.
- Contingency planning.
- Supervision and coordination of data collection, preparation, control and computer room operations.
- Liaison with the IT manager and system development manager.

The operations section also does:

a) Data preparation
Data preparation staff are responsible for converting data from source documents to computer sensible form.

Duties are:
- Correctly entering data from source documents and forms.
- Keeping a record of data handled.
- Reporting problems with data or equipment.

b) Data control
Data control staff are generally clerks. Duties include:
- Receiving incoming work on time.
- Checking and logging incoming work before passing it to the data preparation staff.
- Dealing with errors and queries on processing.
- Checking and distributing output.

Computer room manager
Duties include:
- Control of work progress as per targets.
- Monitoring machine usage.
- Arranging for maintenance and repairs.

Computer operators
Controls and operates hardware in the computer room.
Duties include:

- Starting up equipment.
- Running programs.
- Loading peripherals with appropriate media.
- Cleaning and simple maintenance.

Files librarian
Keeps all files organized and up to date. Typical duties are:

- Keeping records of files and their use.
- Issuing files for authorized use.
- Storing files securely.

3) System Support Section
This section is charged with responsibilities over database and network management

Database management
The database administrator. He is responsible for the planning, organization and control of the database. His functions include

- Coordinating database design.
- Controlling access to the database for security and privacy.
- Establishing back-up and recovery procedures.
- Controlling changes to the database.
- Selecting and maintaining database software.
- Meeting with users to resolve problems and determine changing requirements.

Network management
The network administrator/controller/manager. Functions include:

- Assignment of user rights.
- Creating and deleting of users.
- Training of users.
- Conflict resolution.
- Advising managers on planning and acquisition of communication equipment.

7. Evaluating effectiveness and efficiency of ICT departments

It is important to measure how a system, organization or a department performs, mainly its efficiency and effectiveness.

Efficiency is a ratio of what is produced to what is consumed. It ranges from 0 – 100%. Systems can be compared by how efficient they are.

SYSTEM DEVELOPMENT LIFE CYCLE (WATERFALL MODEL)

This is also known as traditional system development method or function driven method or process driven method. The method requires the analyst to follow a sequence of phases during the development and implementation of an information system. This involves people and is described as information system development project. The following are the system development cycle phases or stages:

1. Preliminary survey/study
2. Feasibility study
3. Facts finding and recording
4. Analysis
5. System design
6. System development
7. System implementation

1 Preliminary study

This stage involves determination of whether there is need to change the existing system or business procedures. It may require management requests for a change of the existing system to give an organization a competitive advantage or to improve the staff morale. The user department should be involved during the definition of the problem. The problem to be solved should be very specific, clear and precise. It should not be too broad to cause ambiguities in its solution.

Objectives of the preliminary study are:

- To understand organizational characteristics and its objectives
- To understand organizational structure
- To identify organizational mission and collect relevant data or document regarding organizational information.
- To develop a brief and accurate problems statement usually known as system term of reference (TOR).

2. Feasibility study

This is a more detailed study carried out by a feasibility study team. Its purpose is to define the problem and decide whether or not a new system to replace the existing one is viable or feasible. During the study, the analyst should assess the magnitude of the problem and attempt to restrict or at least identify the scope of the project. The analyst must list precisely the problems of the current system and also indicate what would be required of the new system. He must identify alternative solutions to the problems and recommend the most cost effective solution.

Feasibility study activities include:

- Identification of main characteristics of the existing system
- Determination of the main output requirements
- Considerations of alternative ways of meeting similar requirements.
- Preparation of gross estimates of developments, implementation and operation costs for each probable alternative solution.
- Documentation of the study i.e. writing of feasibility study report.
- Preparation of gross estimates of possible direct and indirect benefits for each probable alternative.

The following are the areas of feasibility study:

a) Technical Feasibility
b) Social Feasibility
c) Economical Feasibility
d) Legal Feasibility

3. Fact finding/investigation

This involves collection of information about the existing system on which to base analysis in order to determine whether users current needs are being met. The following are some of the activities that are looked at:

a) Functional requirement – the requirements should be established
b) Determination of the proposed system requirements – this is necessary as it may suggest a change in the existing system requirement.
c) Establish any weaknesses or problems associated with the present system, working methods and procedures.
d) Determination of organizational growth rate – this will assist in determination of the growth of the volume of transactions to be processed.
e) Determination of the organization structure, objective and the cost associated with the present system.

Fact-finding comprises of the following activities:

i. Fact-gathering
ii. Fact-recording
iii. Fact-evaluation

4. Analysis

A system analysis involves evaluation of the current system using the gathered facts or information. One should evaluate whether the current and projected user needs are being met. If not, he should give a recommendation of what is to be done. Analysis involves detailed assessment of the components of the existing system and the requirements of the system.

The objectives or aims of system analysis are:

- To determine information needs of an organization and the users of that information
- Determination of the current activities of the system i.e. functions involved in conversion of inputs to outputs
- Determination of the intended systems output
- Determination of the resources required for the intended system
- Determine capabilities required in the system to meet information needs of the organization

5. System design

The objective system design is to put a logical structure of the real system in a form that can be interpreted by other people apart from the designer. The analyst should derive a logical model of the way the existing system works. There is an assumption that the existing system provides a good guide to what is required of a new system. It should be different from how the new system is to achieve the given requirement.

Limitations of system design include:

- There could be some requirements of the new systems that are not currently being satisfied by the current system. These requirements should not be taken into account.

- Inefficiency in the current system may be translated into a logical model and these will be transferred to the new system. Ideally, the models should reveal the logic of an efficient system and should be amended accordingly.
- It is likely that physical aspects of the existing system may be transferred to the logical analysis. The analysts should guard against that.

The above limitations can be dealt thus:

- Treatment of the new requirement: The new requirement can be estimated through interviews with management and users. It is important that the logical model be amended to reflect the new requirements. They are likely to lead to new processes that are added to higher-level design.
- Treatment of inefficiencies: The model should be adjusted through the decomposition of top level design tools e.g. DFDs. The lower level data flow diagram tend to be determined partly by what is done in existing system to fulfil a function.
- Treatment of physical aspects: Certain physical considerations may have shifted into a logical model e.g. a data store or file may contain extra information which may require amendment e.g. to incorporate separate files.

There are two types of design: logical design and physical design.

Logical Design

A logical design produces specifications of major features of the new system, which meets the system's objectives. The delivered product of the logical design is a blueprint of the new system. It includes the requirements of existing system components:

- Outputs (reports, displays, timings, frequencies etc)
- Inputs (dialogs, forms, screens etc)
- Storage (requirement for data to be stored in databases)
- Procedures (to collect, transform and output data)
- Controls (requirements for data integrity, security, data recovery procedures)

Note: Logical design of the system is viewed in terms of what process i.e. procedures, inputs, outputs, storage and control the new system should have.

Physical Design

It takes the logical design blueprint and produces the program specification, physical files or database and user interface for the selected or targeted hardware and software. Physical design is mostly concerned with how the current system or future system works in terms of how the programs are written, files organized in storage media and how tasks are carried out for user interface with the system.

System design objectives

The designed system should meet the following criteria:

- User needs are met as cost effectively as possible
- One that is within the constraints laid down in the terms of reference
- Produce correct outputs by processing data accurately and efficiently
- Simple to operate i.e. easy to use
- One with sufficient built in controls and provide feedback to its user
- Should be reliable

- Should be functional

System design constraints

- The budget: A well-designed system incurs greater expenses. The total system cost of meeting the objectives must be considered in the light of the available budget.
- Time: Time taken to produce a very usable system would increase development cost and delay system delivery.
- Integration with other existing system: Existing and planned system may limit option and available features of the system.
- Skills: Limitation may arise from the range of skills and level of competence in both the design team and the system users.
- Standards: Standards may drive the design tasks in a specified direction.

6. System development

This involves programming, testing and documentation activities.

(a) Programming

This activity involves translation of system specification into program code. A programmer should integrate user requirements into the computer system. Programming standards should be adhered to e.g. use of a standard programming language. Decomposition of a program into smaller units or modules should be implemented as per the design specifications. It is important that the programming team work in cooperation to improve the quality of programs produced.

The contents of a good program specification are:

- Document details: This includes title, program identifier i.e. name, author, version number, reviewer of the program etc.
- Introduction: contains a brief summary of what the program does in business application area
- Assumption and restriction: this lists any constraints on the program or information that affects the logic of the problem.
- Attributes: this outlines the program environment e.g. hardware, operating system, programming language etc
- Data: inputs and outputs of the program
- Functional description: the processing or tasks carried out to convert program input into meaningful outputs
- Detailed processing requirement: indicates functional description i.e. low level detailed view of the processing paths
- Operation consideration: Then describes how operations interact with the program in the normal running and how he can recover to save state or restore the program if anything goes wrong
- Sub-routines: these are modules or segments used by the program as well as their input parameters.
- Messages: identifies message sent and received by the program and their purpose
- Print layout: Describes print or screen dialogue or layout of the program.

(b) Testing

Generally all programs should be tested before system conversion. There are two major program-testing techniques: white box and black box testing.

White box testing

It concentrates on internal construction of a program. It is carried out on the following:

i. Cyclomatic complexity - are measures of logical complexity of a program
ii. Graph matrix - are used for condition testing
iii. Data flow testing – commonly associated with SSADM. It is used to select paths of a program according to location and definition of variables.
iv. The loop testing – it focuses on exclusive validity of loops within a program

Black box testing

It focuses on functional requirements of software. It attempts to find errors in the following categories:

- Incorrect or missing functions
- Interface errors
- Data structure errors
- Performance errors
- Initialisation and termination errors

These methods are based on the input and output to and from a program. They do not emphasize on the internal structure of a program.

(c) Documentation

Software documentation is a description of software or system after its development. Software product therefore comprises of code and documentation. Documentation includes a wide range of technical and non-technical manuals, books, descriptions and diagrams relating to the use and operation of produced software. It is vital for software engineering to allocate adequate time to the software engineering particularly documentation throughout its development.

Documentation is produced for:

- System developer – who will depend on documentation from previous life cycle stages to guide continued development and subsequent maintenance of software or system.
- Management – who use documentation from past projects to plan and understand current projects
- System users – who learn how to use software or system from its narrative description or documentation.

Importance of system documentation

(i) It guides the development team at various stages of the development life cycle
(ii) Can be used as a system backup copy to recover the system should something happen to its implementation
(iii) It aids or assists during system maintenance since it guides in identification of system modules to be changed
(iv) It can effectively provide a checklist of items to be covered during subsequent system audit or system maintenance
(v) It guides against loss of system understanding particularly when the author leaves the company or dies
(vi) It may act as a training guide or document to new programmers, analysts or users who may join after system implementation

7. System implementation

This phase involves the following activities:

a) Hardware selection, acquisition and installation
b) User training

c) File conversion/creation
d) Changeover

Hardware and software acquisition

A user may acquire the hardware and software directly from a manufacturer and developer respectively. He may also purchase them from an intermediate supplier. Whichever way, carefully controlled purchasing procedures should be followed. The procedures should include invitation to tender and comparative analysis to determine the appropriate supplier of the required hardware and software.

Choosing hardware and software

Software factors

Factors influencing choice of software includes:

(i) User requirements: the selected software or package should fit user requirement as closely as possible
(ii) Processing time: these involves the response time e.g. if the response time is slow the user might consider the software or package as unsuccessful
(iii) Documentation: the software should be accompanied by manual, which is easy to understand by non-technical person. The manual should not contain technical jargon.
(iv) User friendliness: the package should be easier to use with clear on screen prompts, menu driven and extensive on screen help facility
(v) Controls: the software should have in-built controls which may include password options, validation checks, audit trails or trace facilities etc
(vi) Up-to-date: the software should be up-to-date e.g. should have changes or corrections in line with business procedures
(vii) Modification: one should consider whether the user could freely change the software without violating copyright.
(viii) Success in the market: one should consider how many users are using the software and how long it has been in the market
(ix) Compatibility of the software: how the software integrates with other software particularly the operating system and the user programs
(x) Portability: one should consider how the software runs on the user computer and whether there will be need for the user to upgrade his hardware
(xi) Cost: the user company should consider its financial position to establish whether it can afford the software required for efficient operations rather than the least cost package software available.

Hardware factors

Custom-built hardware is a rare necessity. Most hardware is standard, compatible, off-the-shelf components. It is cheaper, easy to maintain, and ensures compatibility with equipment in your organization and your partners and clients.

The system analysis and design should have precisely determined what sort of hardware is needed - down to the make and model.

The decision of hardware choice must consider many factors:

- Future needs - can the equipment be expanded or added to?
- Availability (is it only available overseas?)
- Capacity (e.g. is the hard disk big enough to hold all your data? Is it fast enough?)
- Reliability - can it be depended on?
- Cost - initial cost, running costs, upgrade costs, repair costs, training costs
- Compatibility - with your other equipment, and that of your partners and clients
- Warranty and support - in case of failure or problems

- Ease of use and installation
- Compliance with local conditions (e.g. power supplies must be 240V or compliant with telecommunication systems)

8. Post implementation review

It is an important activity which like training and testing is continuous. It involves measuring or assessment of system development stages and the final produced system. It may be carried out from the third to seventh month after changeover. The development team members, the users, auditors, management representative and those affected by the system may take part in the exercise. This is to ensure that specified objectives are met and are justifiable in terms of cost, benefits and other performance criteria.

The review focuses on the following areas:

a) Comparison of the actual system performance against the anticipated performance objectives. This involves assessment of system running cost, benefits etc as they compare with estimated or anticipated.

b) The staffing needs and whether they are more or less than anticipated

c) Any delays in the processing and effects of such delays

d) Effectiveness of the inbuilt security procedures in the system

e) The error rates for input data

f) The output i.e. whether it is correct, timely and distributed correctly to the relevant users

Evaluation of a system should be carried out after completion of every stage of SDLC.

9. System maintenance

It involves changing part of the system according to the recommendations of the post implementation review team.

Causes of system maintenance include:

- Defects in the system after its delivery. This involves any errors or bugs in the newly implemented system e.g. use of wrong formula within a system
- Environment change e.g. a government tax policy may change which would influence a change of payroll system
- A change in user requirement. A business organization exist in a changing environment, therefore the user requirements change e.g. a payslip in a payroll system may initially be required to show the employee corporate share amount. Employees may feel that such information should not appear in the payslips and thus influence a change of the system.
- Poor documentation of the system. It makes it difficult for one to understand the system, and also to change it should there be a need to do so. A system may be changed and its documentation rewritten in order to improve it is maintainability.

System maintenance is carried to improve the system adaptability and flexibility. Flexibility involves minor changes in a system in order to cope up with the growth in business transaction volume. Adaptability involves changing a system in order to benefit the user from advances in both software and hardware technology.

The process of the system maintenance should be controlled by the system analyst.

When a manager or a user suggests a change to the system regardless of the reasons:

a) The analyst should prepare diagrams and estimate the impact
b) The change control board decides whether or not to implement the change.

c) If change could take place, the analyst modifies all the documentation by merging the diagram and estimates into the existing problem and designs specification.
d) The programmers and testing teams are responsible for incorporating any change into the programs. They test the system to ensure that no errors or problem are introduced as a result of change.
e) Once the change is satisfied as default free, the revised system is adopted immediately.

Types of system maintenance

a) Corrective maintenance
b) Perfective maintenance
c) Adaptive maintenance
d) Preventive maintenance
e) Replacive maintenance

REINFORCING QUESTIONS (Computational Methods and Data Analysis III.

QUESTION ONE

(a) What is an information system? What are the various components of an information system? (6 Marks)

(b) Differentiate between structured and unstructured decisions. Give examples of such decisions. (4 Marks)

(c) Describe the relevance of the following to a Decision Support System (DSS) :

(i) Specialized packages (2 Marks)

(ii) Query Languages (2 Marks)

(iii) Database Management System (2 Marks)

(d) Explain what Office Automation System and Knowledge Work System mean.(4 Marks)

(Total: 20 marks)

QUESTION TWO

(a) Propose the type of information system you would recommend for the following applications:

(i) Maintenance of general ledger (1 Mark)

(ii) Formulation of competitive market strategies (1 Mark)

(iii) Financial sensitivity or risk analysis (1 Mark)

(iv) Ticket reservations (1 Mark)

(Question 5c Dec 2002)

(b) Identify the major factors that influence the structure of an information system. (4 Marks)

(c) Examine the contribution of information systems in the decision-making or problem solving process. (4 Marks)

(d) Suggest possible uses for an expert system within the Customer Database Department. (6 Marks)

(e) Why do executives need executive information systems? (2 Marks)

(Total: 20 marks)

QUESTION THREE

(a) Organizational information systems are categorized under:

(i) Transaction Processing System (TPS)

(ii) Management Information System (MIS)

(iii) Decision Support System (DSS)

(iv) Executive Information System (EIS)

(v) Expert System (ES)

Required:

Suggest one application of each of the systems types listed above for each of the following areas of business.

- Sales and Marketing (5 Marks)
- Finance (5 Marks)

(b) The general manager of a large organization has asked you to draw up a document identifying eight important characteristics against which managers can evaluate the success of an information system together with a brief explanation of each. What would your document contain? (8 Marks)

(c) What is artificial intelligence? (2 Marks)

(Total: 20 marks)

QUESTION FOUR

(a) Discuss the various components of a Decision Support System. (12 Marks)

(b) When is it appropriate to use a DSS? (8 Marks)
(Total: 20 marks)

QUESTION FIVE
(a) Give a brief definition of an Expert System (ES) (3 Marks)
(b) Describe five properties of an expert system. (10 Marks)
(c) What are the components of an expert system? (7 Marks)
(Total: 20 marks)

QUESTION ONE
(a) Define fourth-generation languages and list the categories of fourth-generation tools. (10 Marks)
(b) What is the difference between fourth-generation languages and conventional programming languages? (4 Marks)

(c) What is object-oriented programming? How does it differ from conventional software development?(6 Marks)
(Total: 20 marks)

QUESTION TWO
(a) Discuss the various components of an information system. (5 marks)

(b) Describe the three main levels of decision making within an organization, defining their characteristics and users. Outline the information characteristics for each level. (15 marks)
(Total: 20 marks)

QUESTION THREE
(a) Information systems should be designed and developed to enhance the efficiency and effectiveness of organizational processes. They should therefore be effective and efficient in their use. What factors affect the efficiency and effectiveness of information systems? (10 Marks)
(b) What is an expert system? Discuss its components and the advantages of using an expert system. (10 Marks)
(Total: 20 marks)

QUESTION FOUR
(a) Briefly define what is a Management Information System. Discuss the various reports output by an MIS.(10 Marks)

(b) Define office automation. What are the objectives of office automation? (10 marks)
(Total: 20 marks)

QUESTION FIVE
(a) List the characteristics of a good software design. (4 Marks)
(b) Differentiate between white box testing and black box testing. (4 Marks)
(c) Describe Joint Application Development and show its usefulness in software development. (6 Marks)
(d) Briefly describe three areas of feasibility study. (6 Marks)
(Total: 20 marks)

QUESTION SIX
(a) Define CASE and show how it improves productivity in the software development environment. (6 Marks)

(b) Discuss the advantages and disadvantages of the traditional system

development life cycle (waterfall model) .(6 Marks)

(c) Define prototyping and list various advantages and disadvantages of prototyping.(8 Marks)
(Total: 20 marks)

QUESTION SEVEN
(a) Differentiate between formal and informal information systems. (4 Marks)

(b) Once the system has been constructed and tested the system needs to be delivered to the users and made operational. Briefly describe four activities done during the implementation of a system.(8 Marks)

(c) The user interface is becoming more important as systems become more and more interactive. Discuss four principles of good user interface design. (8 Marks)
(Total: 20 marks)

QUESTION EIGHT
(a) Identify five reasons that contribute to late completion and delivery of software. (5 Marks)
(b) Name five factors that are to be considered when acquiring hardware. (5 Marks)
(c) List five factors that should be considered when selecting a hardware supplier.(5 Marks)
(d) List five tools and techniques used in the documentation design of a system. (5 Marks)
(Total: 20 marks)