International Association Of Certified Practicing Engineers	**www.iacpe.com** **Knowledge, Certification, Networking**	**Page : 1 of 96** **Rev: 01** **Rev: 01 – May 2016**
IACPE **No 19, Jalan Bilal Mahmood** **80100 Johor Bahru** **Malaysia**	**INTRODUCTION TO INFORMATION SYSTEMS** **CPE LEVEL II TRAINING MODULE**	

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INTRODUCTION

Scope

Information systems have become the backbone of most organizations. Banks could not process payments, governments could not collect taxes, hospitals could not treat patients, and supermarkets could not stock their shelves without the support of information systems. In almost every sector—education, finance, government, health care, manufacturing, and businesses large and small—information systems play a prominent role.

Every day work, communication, information gathering, and decision making all rely on information technology (IT). When we visit a travel agency to book a trip, a collection of interconnected information systems is used for checking the availability of flights and hotels and for booking them. Most companies and institutions rely heavily on their information systems. Organizations such as banks, online travel agencies, tax authorities, and electronic bookshops can be seen as IT companies given the central role of their information systems.

This module aims to introduce you to the foundation concepts on designing and implementing information systems, necessary for advanced data management and data analysis.

This module provides you with a detailed discussion about entities and attributes and how you can track these in various sources of information, discusses in detail how to establish a relationship between two entities, describes some principles of relational databases and presents the various techniques that you can use to transform your Entity Relationship model into a physical database design. This module provides you with a detailed about SQL’s fundamental constructs and concepts.

General Considerations

A. Definition of system

A system is a set of inter-related, inter-connected or inter-dependent elements that operates collectively to accomplish some common purpose or goal. For example: Business organization (Elements: Men, Machine, Material, Method Money etc. Objective: Maximization of Profit).[1]

All the elements of a system can be classified into two main categories: Abstract elements and Physical elements. The elements which can't be seen and touched but their presence can only be felt are called abstract and the elements which can be seen and touched are called physical. E.g. In Business organization money, material machine are all physical elements and the business processes like marketing, forecasting, planning are abstract.

B. Types of System

Systems can be distinguished on the basis of the following :

a) According to Elements

- Abstract System : Abstract system also known as Conceptual System or Model can be defined as an orderly arrangement of interdependent ideas or constructs

- Physical System : A physical system is a set of tangible elements which operate together to accomplish an objective.

b) Interactive Behavior

A system may be composed of a number of components that work together in a cascade to achieve a goal for which the system is designed. All systems work in a specific environment and based on how they perform within an environment, systems can be categorized in two classes:

- Open System : A system that interacts freely with its environment by taking input and returning output is termed as an Open System. With

change of environment, an open system also changes to match itself with the environment.

- Closed System : A system that does not interact with the environment nor changes with the change in environment is termed as a Closed System. Such systems are insulated from the environment and are not affected with the changes in environment. Closed systems are rare in business area but often available in physical systems that we use in our day to work.

c) According to Degree of Human intervention

- Manual Systems : Manual Systems are the systems where data collection, manipulation, maintenance and final reporting are carried out absolutely by human efforts.

- Automated Systems : Automated Systems are the systems where computers or microprocessors are used to carry out all the tasks mentioned above. However, none of the business system is 100% automated; rather, to some extent, it depends on manual intervention, may be in a negligible way.

d) According to Working/Output

- Deterministic System : A deterministic system operates in a predictable manner wherein the interaction among the parts is known with certainty. If one has a description of the state of the system at a given point in time plus a description of its operation, the next state of the system may be given exactly, without error. An example is a correct computer program, which performs exactly according to a set of instructions.

- Probabilistic System : The probabilistic system can be described in terms of probable behavior, but a certain degree of error is always attached to the prediction of what the system will do. An inventory system is an example of a probabilistic system. The average demand, average time for replenishment, etc, may be defined, but the exact value at any given time is not known. Another example is a set of instructions given to a human

who, for a variety of reasons, may not follow the instructions exactly as given.

C. General model of a system

A general model of a physical system is input, process and output. This is, of course, very simplified because a system may have several inputs and outputs as showing in

Figure **1** :

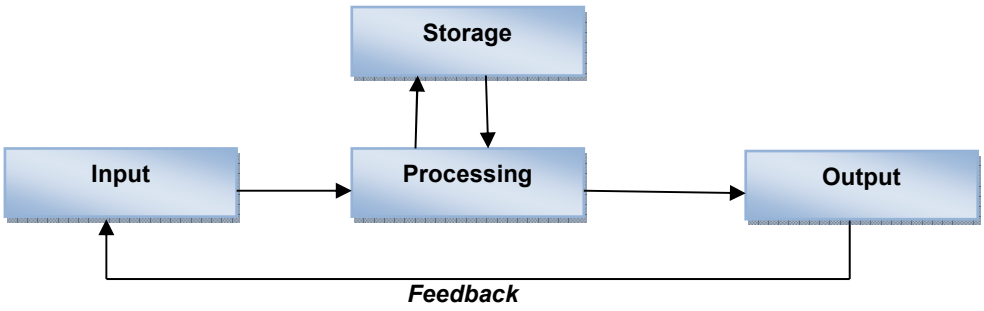


Figure 1 General model of system

A System may have many inputs and outputs.

- Input is the data flowing into the system from outside. For example : A newspaper takes a news feed from a news wire service.

- Processing is the action of manipulating the input into a more useful from. For example : The newspaper takes the pure text obtained from the news wire service and creates front page layout using pictures and formatted text.

- Output is the information flowing out of a system. For example : The raw news wire information is viewed on your website as a story, all nicely formatted in the company style.

- Storage is the means of holding information for use at a later date.

- Feedback occurs when the outcome has an influence on the input.

D. System environment

The external world which is outside the system boundary is known as System Environment.

a) System Boundary : All systems function within some sort of environment, which is a collection of elements. These elements surround the system and often interact with it. For any given problem, there are many types of systems and many types of environments. Thus, it is important to be clear about what constitutes the system and the environment of interest.

   For example, a physiologist looking at human system may be interested in studying the entire human body as a system, and not just a part of it (such as the central nervous system only). If the entire human body is the system of interest, the physiologist is likely to define the environment more broadly than he might if the focus was on just the central nervous system.

   The features that define and delineate a system form its boundary. The system is inside the boundary; the environment is outside the boundary. In some cases, it is fairly simple to define what is part of the system and what is not; in other cases, the person studying the system may arbitrarily define the boundaries. Some examples of boundaries are discussed in Table 1

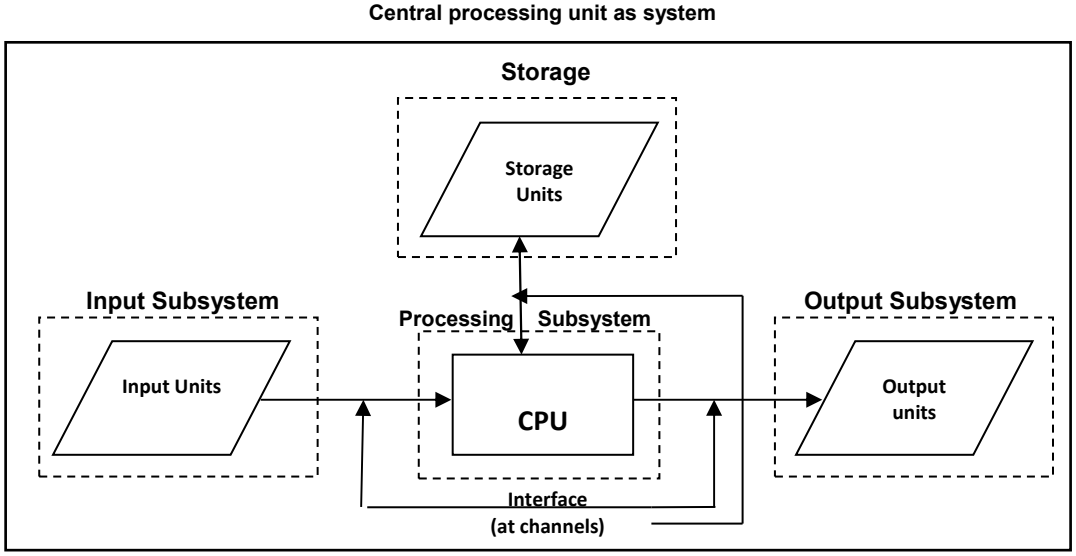
Table 1 Examples of Systems and their boundaries

System	Boundary
Human	Skin, hair, nails, and all parts contained inside form the system; all things outside are environment.
Automobile	The automobile body plus tires and all parts contained within form the system.
Production	Production machines, production inventory of work in process, production employees, production procedures, etc. form the system. The rest of the company is in the environment.

b) Subsystem : A subsystem is a part of a larger system. Each system is composed of subsystems, which in turn are made up of other subsystems, each sub-system being delineated by its boundaries.

The interconnections and interactions between the subsystems are termed Interfaces. Interfaces occur at the boundary and take the form of inputs and outputs.

Figure 2 shows examples of subsystems and interfaces at boundaries.



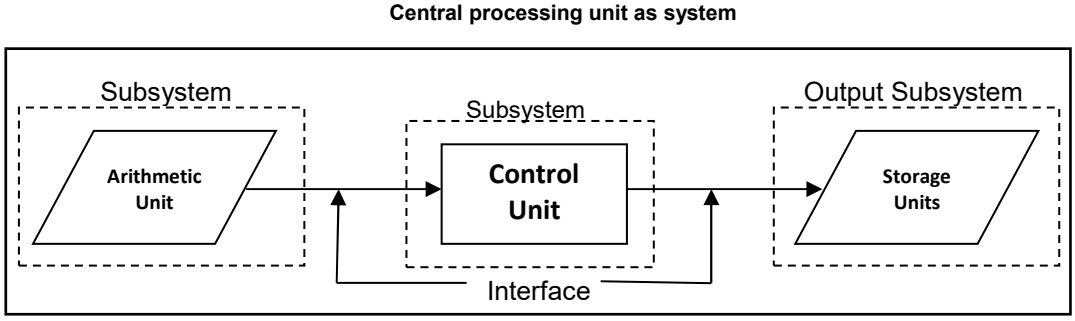


Figure 2 Components of a Computer System

c) Characteristics of Subsystems: The use of subsystems as building blocks is basic to analysis and development. This requires an understanding of the principles, which dictate how systems are built from subsystems.

- Decomposition: A complex system is difficult to comprehend when considered as a whole. Therefore the system is decomposed or factored into subsystems. The boundaries and interfaces are defined, so that the sum of the subsystems constitutes the entire system. This process of decomposition is continued with subsystems divided into smaller subsystems until the smallest subsystems are of manageable size.

  The subsystems resulting from this process generally form hierarchical structures (**Figure 3**). In the hierarchy, a subsystem is one element of supra-system (the system above it).

  Decomposition into subsystems is used to analyze an existing system and to design and implement a new system. In both cases, the investigator or designer must decide how to factor, i.e., where to draw the boundaries. The decisions will depend on the objectives of the decomposition and also on individual differences among designers, the latter should be minimized.

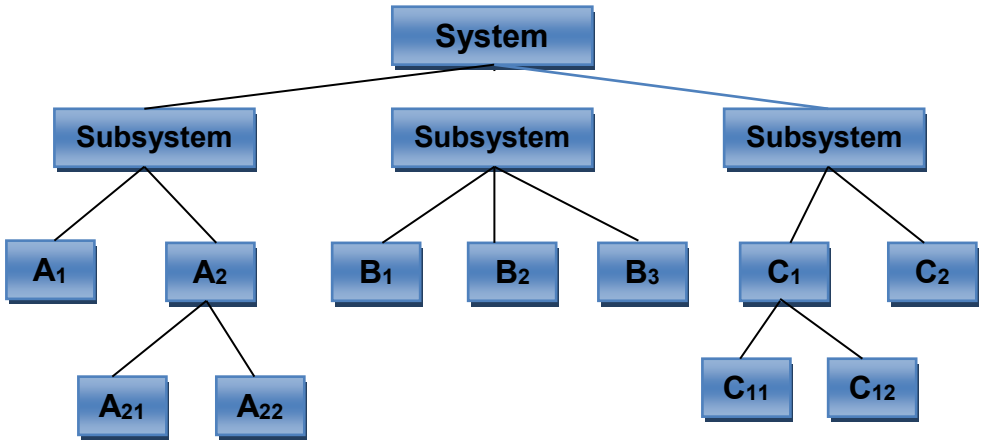


Figure 3 Hierarchical Relations of Subsystems

- Simplification: Simplification is defined as the process of organizing subsystems so as to reduce the number of interconnections, which is a potential interface for communication among subsystems. The number of interconnections if all the subsystems interact is in general 1/2n (n-1), where n is the number of subsystems.
- Decoupling: If two different subsystems are connected very tightly, very close coordination between them is required. For example, if the raw material is put directly into production the moment it arrives at the factory, the raw materials system can be said to be tightly couple. Under these conditions, raw material delivery (input to production system and output from raw material system) must be precisely timed in order to avoid delays in production or to prevent new material from arriving too soon with no place to be stored.

d) Supra-System: A Supra-System refers to the entity formed by a system and other equivalent systems with which it interacts. For example, an organization may be subdivided into numerous functional areas such as marketing, finance, manufacturing, research and development, and so on.

   Each of these functional areas can be viewed as a subsystem of a larger organizational system because each could be considered to be a system in and of itself. For example, marketing may be viewed as a system that consists of elements such as market research, advertising, sales, and so on. Collectively, these elements in the marketing area may be viewed as making up the marketing Supra-System. Similarly the various functional areas (subsystems) of an organization are elements in the same supra-system within the organization.

e) System Stress and System Change: Systems whether living or artificial systems like organizational systems, information systems, change because they undergo stress. A stress is a force transmitted by a system's supra-system that causes a system to change, so that the supra-system can better achieve its goals. In trying to accommodate the stress, the system may impose stress on its subsystems and so on.

   When a supra-system exerts stress on a system, the system will change to accommodate the stress, or it will become pathological; that ism it will decay and terminate. A Supra-system enforces compliance by the system through its control over the supply of resources and information input to the system. If the system does not accommodate the stress the supra-system decreases or terminates the supply of matter energy and information input to the system. If the system does not accommodate the stress, the supra-system decreases or terminates the supply of matter energy and information input.

   Systems accommodate stress through a change in the form; there can be structural changes or process changes. For example - a computer system under stress for more share-ability of data may be changed through the installation of terminals in remote locations - a structural change.

Demands for greater efficiency may be met by changing the way in which it sorts the data - a process change.

E. Information

According to Davis and Olson – "Information is data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current and progressive decision." The term data and information are often used interchangeably. However the relation of data to information is that of raw material and finished goods. Information is a basic resource in the modern society. It is a substance on which business decisions are based. Therefore the quality of decision depends upon the quality of information. This phenomenon is also called GIGO (Garbage In Garbage Out).[5]

a. Attributes of Information

Some of the important attributes of useful and effective information are as follows:

- Availability: Availability or timeliness is a very important property of information. If information is not available at the time of need, it is useless. Data is organized in the form of facts and figures in database and files from were various information is derived for useful purpose.

- Purpose: Information must have purposes at the time it is transmitted to a person or machine, other wish it is a simple data. Information communicated to people has a variety of purposes because of the variety of activities performed by them in business organizations. The basic purpose of information is to inform, evaluate, persuade, and organize.

- Mode and format: The mudes of communicating information to humans are sensory (through, sight, hear, taste, touch and smell) but in business they are either visual, verbal or in written form.

- Decay: Value of information usually decay with time and usage and so it should be refreshed from time to time. For example, we access the running score sheet of a cricket match through internet sites and this score sheet is continually refreshed at a fixed interval or based on status of the state. Similarly, in highly

fluctuating share market a broker is always interested about the latest information of a particular stock/s

- Rate: The rate of transmission/reception of information may be represented by the time required to understand a particular situation. A useful information is the one which is transmitted at a rate which matches with the rate at which the recipient wants to receive, Quantitatively, the rate for humans may be measure by the number of numeric characters transmitted per minute, such as sales reports from a district office. For machines the rate may be based on the number of bits of information per character (sign) per unit of time.

- Frequency: The frequency with which information is transmitted or received affects its value. Financial reports prepared weekly may show so little changes that they have small value, whereas monthly reports may indicate changes big enough to show problems or trends.

- Completeness: The information should be as complete as possible. For example - A model for investment decisions provides information on mean, standard deviation and the shape of the distribution of ROI and NPV. With this complete information, the manager is in a much better position to decide whether or not to undertake the venture.

- Reliability: It is just not authenticity or correctness of information; rather technically it is a measure of failure or success of using information for decision-making. If information leads to correct decision on many occasions, we say the information is reliable.

- Validity: It measures the closeness of the information to the purpose which it purports to serve. For example, some productivity measure may not measure, for the given situation, what they are supposed to do e.g., the real rise or fall in productivity. The measure suiting the organization may have to be carefully selected or evolved.

- Quality: Quality refers to the correctness of information. Information is likely to be spoiled by personal bias. For example, an over-optimistic salesman may give rather too high estimates of the sales. This problem, however, can be circumvented by maintaining records of salesman's estimates and actual sales and deflating or inflating the estimates in the light of this.

- Transparency: If information does not reveal directly what we want to know for decision-making, it is not transparent. For example, total amount of advance does not give true picture of utilization of fund for decision about future course of action; rather deposit-advance ratio is perhaps more transparent information in this matter.

- Value of information: It is defined as difference between the value of the change in decision behavior caused by the information and the cost of the information. In other words, given a set of possible decisions, a decision-maker may select one on basis of the information at hand. If new information causes a different decision to be made, the value of the new information is the difference in value between the outcome of the old decision and that of the new decision, less the cost of obtaining the information.

- Adequacy: To be useful, information must be adequate so that the desired actions can be initiated. Required information should flow on different directions within the organization and to and from its environment. Further, the type of information that flows within the organization or across, it should have adequate and relevant contents.

b. Types of information

Information, broadly, can be divided into two different types: Internal Information and External Information in the context of business organizations.

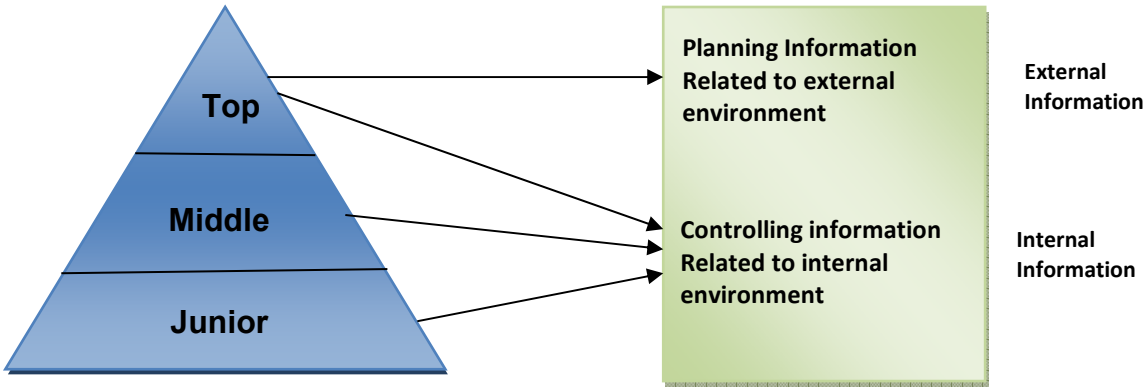


Figure 4 External and Internal Information

Internal information: The internal information can be defined as an information that has been generated from the operations of the organization at various functional areas. The internal information gets processed and summarized from junior to top most level of management. The internal information always pertains to the various operational units of the organization. Examples of internal information would be production figures, sales figures, information about personnel, accounts, material etc.

External information: The external information is collected from the external environment of the business organization. External information is considered to affect the organizational performance from outside the organization.

F. Information system : Definition

Information system has been defined in terms of two perspectives: one relating to its function; the other relating to its structure. From a functional perspective; an information system is a technologically implemented medium for the purpose of recording, storing, and disseminating linguistic expressions as well as for the supporting of inference making. From a structural perspective; an information system consists of a collection of people, processes, data, models, technology and partly formalized language, forming a cohesive structure which serves some organizational purpose or function.[4]

An information system can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products.

Three activities in an information system produce the information that organizations need to make decisions, control operations, analyze problems, and create new products or services. These activities are input, processing, and output. Input captures or collects raw data from within the organization or from its external environment. Processing converts this raw input into a more meaningful form. Output transfers the processed information to the people who will use it or to the activities for which it will be used. Information systems also require feedback, which is output

that is returned to appropriate members of the organization to help them evaluate or correct the input stage.

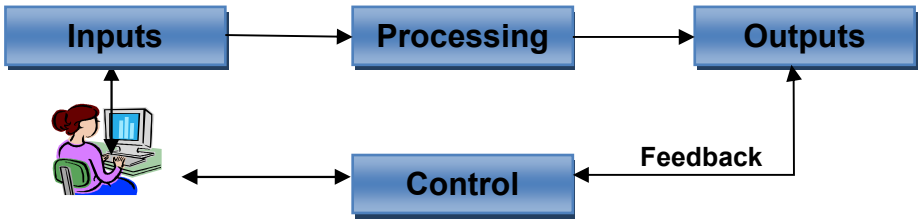


Figure 5 Function of an information system

G. Components of Information Systems

a. Resource of people

- End users: (also called users or clients) are people who use an information system or the information it produce. They can be accountants, salespersons, engineers, clerks, customers, or managers. Most of us are information system end users.

- IS specialists: people who actually develop and operate information system. They include systems analysts, programmers, testers, computer operators, and other managerial, technical, and clerical IS personnel. Briefly, systems analysts design information systems based on the information requirements of end users, programmers prepare computer programs based on the specifications of systems analysts, and computer operators operate large computer systems.

b. Hardware

- Machines: as computers and other equipment along with all data media, objects on which data is recorded and saved.

- Computer systems: consist of variety of interconnected peripheral devices. Examples are microcomputer systems, midrange computer systems, and large computer systems.

c. Software

Software Resources includes all sets of information processing instructions. This generic concept of software includes not only the programs, which direct and control computers but also the sets of information processing (procedures). Software Resources includes:

- System software, such as an operating system
- Application software, which are programs that direct processing for a particular use of computers by end users.
- Procedures, which are operating instructions for the people, who will use an information system. Examples are instructions for filling out a paper form or using a particular software package.

d. Data Resources

Data resources include data (which is raw material of information systems) and database. Data can take many forms, including traditional alphanumeric data, composed of numbers and alphabetical and other characters that describe business transactions and other events and entities. Text data, consisting of sentences and paragraphs used in written communications; image data, such as graphic shapes and figures; and audio data, the human voice and other sounds, are also important forms of data. Data resources must meet the following criteria:

- Comprehensiveness: means that all the data about the subject are actually present in the database.
- Non-redundancy: means that each individual piece of data exists only once in the database.
- Appropriate structure: means that the data are stored in such a way as to minimize the cost of expected processing and storage.

The data resources of IS are typically organized into:

- Processed and organized data-Databases.
- Knowledge in a variety of forms such as facts, rules, and case examples about successful business practices.

e. Network Resources

Telecommunications networks like the Internet, intranets, and extranets have become essential to the successful operations of all types of organizations and their computer-based information systems. Telecommunications networks consist of computers, communications processors, and other devices interconnected by communications media and controlled by communications software. The concept of Network Resources emphasizes that communications networks are a fundamental resource component of all information systems. Network resources include:

- Communications media: such as twisted pair wire, coaxial cable, fiber-optic cable, microwave systems, and communication satellite systems.
- Network support: This generic category includes all of the people, hardware, software, and data resources that directly support the operation and use of a communications network. Examples include communications control software such as network operating systems and Internet packages.

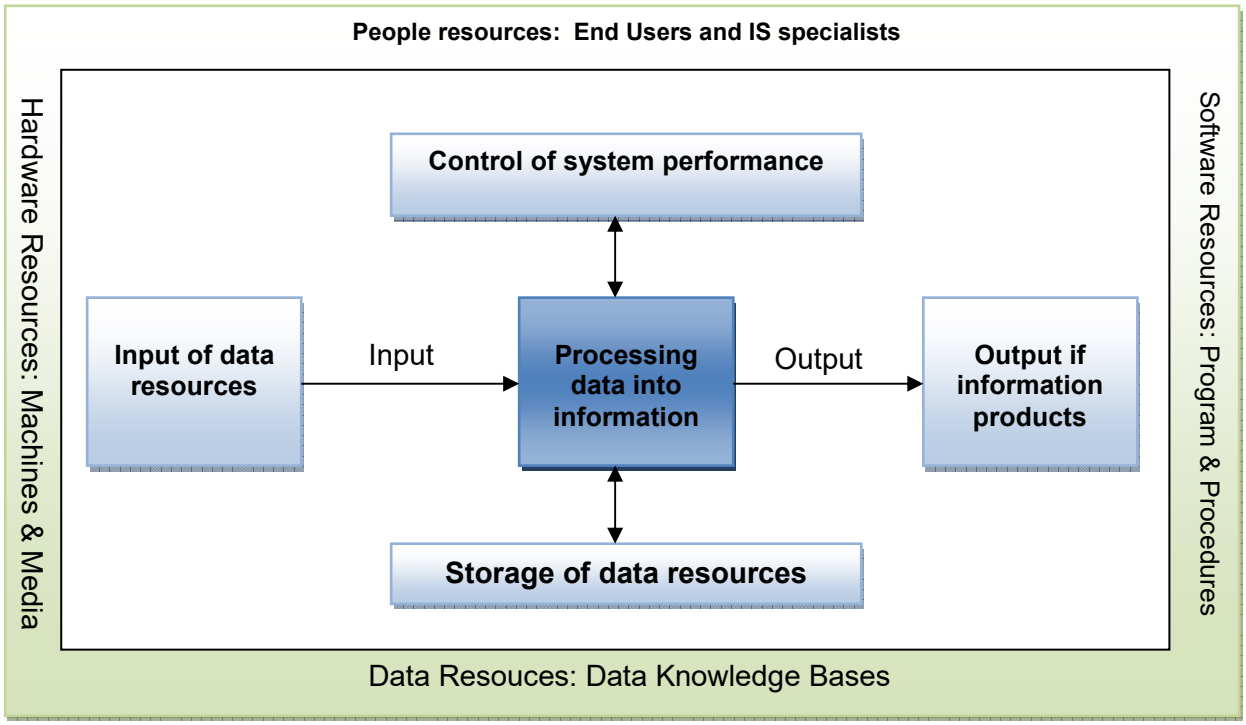


Figure 6 Components of Information System

DEFINITIONS

System - A set of inter-related, inter-connected or inter-dependent elements that operates collectively to accomplish some common purpose or goal

Subsystem - A subsystem is a part of a larger system

Information - Information is data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current and progressive decision

Information system - a collection of people, processes, data, models, technology and partly formalized language, forming a cohesive structure which serves some organizational purpose or function

Hardware - In information technology, hardware is the physical aspect of computers, telecommunications, and other devices.

Software - the programs used to direct the operation of a computer, as well as documentation giving instructions on how to use them.

Database - a set of data.

Entity - An entity represents a set of instances that are of interest to a particular business.

Relationships - A relationship connects two entities. A relationship represents a significant dependency of two entities—always two entities

Table - A table is a collection of related data held in a structured format within a database. It consists of fields (columns), and rows.

Attribute - a piece of information that in some way describes an entity. An attribute is a property of the entity, a small detail about the entity

First normal form - All attributes are single valued

Second normal form - An attributes must be dependent upon entity's entrie unique identifier

Third normal form - No non-UID attribute can be dependent on another non-UID attribute.

Data definition language (DDL) - The SQL DDL provides commands for defining relation schemas, deleting relations, and modifying relation schemas.

Interactive data-manipulation language (DML) - The SQL DML includes a query language based on both the relational algebra and the tuple relational calculus. It includes also commands to insert tuples into, delete tuples from, and modify tuples in the database.

Aggregate functions - Functions that take a collection (a set or multiset) of values as input and return a single value

Null values - to indicate absence of information about the value of an attribute.

dynamic SQL - The dynamic SQL component of SQL allows programs to construct and submit SQL queries at run time

Embedded SQL - the SQL structures permitted in the host language(A language in which SQL queries are embedded) constitute embedded SQL.

Open DataBase Connectivity (ODBC) – ODBC standard defines a way for an application program to communicate with a database server. ODBC defines an application program interface (API) that applications can use to open a connection with a database, send queries and updates, and get back results

JDBC - The JDBC standard defines an API that Java programs can use to connect to database servers. (The word JDBC was originally an abbreviation for "Java Database Connectivity", but the full form is no longer used.)