UNIT 2 INFORMATION SYSTEM DESIGN AND DEVELOPMENT

Structure

2.0 OBJECTIVES

After reding this unit you will be able to:

- understand the implication of the General Systems Theory in information system design;
- prepare a framework for systems design;
- know about the system life cycle;
- analyse an existing information system;
- carry out system implementation; and
- evaluate a system.

2.1 INTRODUCTION

Information systems are required to be managed effectively if they are to give a useful service. The emphasis should be upon the various stages associated with the

development and implementation of a new system . There is also need to manage such the system regularly on day to day basis. The system analysis is an important aspect in system development.

System design is very much linked to the systems analysis phase of any project or activity. We have already discussed in the previous unit that systems analysis is the study of an existing system for the purpose of designing a new or improved system. During the analysis phase, the user's information needs are identified, system performance criteria are defined, a design proposal is prepared, based on requirements and finally approved by the systems team.

The basic approach to information systems design is to make available a broad base of comprehensive information, flowing on a timely basis to those in organizations who can make effective decisions.

In this unit, we will study the design phase in a system project which is possible only after understanding the existing system and the requirements of the new systems. Once the system has been designed, the next step is implementation which involves acquisition and integration of physical and conceptual resources that produce a working system.

A system needs to be evaluated to examine whether it is feasible or not. If not, a new design may be required. Finally, once a system is designed, it is necessary to develop system documentation referred to as communication, which is prepared by the system analyst throughout the developmental cycle of the information system.

2.2 SYSTEM DESIGN

You have already studied in the previous unit about system analysis and understood that system analysis leads to the design of a system. System design includes the organization of people, equipment, money and procedures to process the information. System analysis and design draw heavily on the General Systems Theory as a conceptual background. Given below are the general system theories and the importance of each one in the content of information system design.

	General Systems Theory system design	**Importance for information**
1)	Components of a system interact.	Delineate components and their interrelations during analysis
2)	A system is a whole.	Be sure to define the entire system before examining subsystems.
3)	Systems are goal seeking.	What is the goal of an information system?
4)	Systems have input and output.	A major design task is to specify input and output.
5)	Systems transform input to yield output	A major design task is to specify processing to output. Produce from input.

6) Systems yield entropy.	Information processing is critical to an organization's success.
7) Systems must be controlled.	Information systems help control the organization, information systems have to have feedback on their own performance and be controlled.
8) Systems form a hierarchy.	Information systems design is a hierarchical task, systems consist of hierarchies of subsystems.
9) Systems exhibit differentiation.	Information systems have many specialized parts.
10) Systems exhibit equifinality.	It is better that it is explained through example. There are many ways to design a system to achieve desired goals.

2.2.1 Principles of a Well-designed System

Just as in systems analysis, systems design too needs effective management and is the result of a series of principles. These underlying principles along with the need for creativity are as below:

1) ***Principle of acceptability***

The success of a new system is highly dependent upon its acceptability by organizational personnel or the persons for whom it is designed. For a successful system, the people who use it should participate in its analysis, design and development.

2) ***Principle of enhancing the decision-making process***

The new system should enhance the decision-making ability of organizational personnel. This design approach allows more effective decisions.

3) ***Principle of economy***

For economy in the new system, no information service should be provided that cannot be cost-justified.

4) ***Principle of flexibility***

The new system should be adaptable in a changing environment by allowing easy expansion or contraction.

5) ***Principle of reliability***

Reliability in a new system refers to consistency over an extended period of operation. A high degree of reliability can be designed into the system by including good internal controls.

6) ***Principle of simplicity***

The simplicity of a system can be affected by providing a straight-line flow from one step to the next, avoiding needless backtracking. Additionally, a simplified system is easier to understand and use than a more complex system.

2.2.2 Steps in System Design Process

The key steps in the systems design process are:

a) Review new system requirements

Systems design, devising new system approaches, centers on determining the requirements for a new system. This initial step in systems design management takes into account the information compiled to date on the present system. After system analysts have reviewed appropriate date, they must specify the following:

— New policies consistent with the organization objectives

— Planned inputs

— New methods and procedures

— Data files to be maintained

— Output needs

— Internal control considerations

— Equipment considerations

The foregoing requirements for newly designed systems are not complete until the human factors are considered.

b) Design the new system

It is recommended that a methodical approach to systems design be undertaken initially during this critical phase. Recommended is the modular or building block approach wherein major system functions are successfully separated into distinct minor functions. When the functional analysis is complete, the systems analyst creates a structure for the functional modules that is capable of operating within whatever hardware constraints are imposed. The net result of the modular approach is that duplicated activities are eliminated and the complexity of the overall systems is reduced.

c) Flowchart and document the new system

An important step is preparation of the final system flowcharts for the recommended system, without specifying the equip-ment. Accuracy, simplicity and ease of understanding are the essential components since non-technical personnel may be reviewing and evaluating them.

d) Consider and review system design alternatives with proper personnel

e) Select the more promising alternatives with the help of properly experienced personnel

f) Compare the tangible and intangible benefits of the promising alternatives. Cost factors, volumes and requirements for equipment and personnel should be carefully analysed to check the validity

g) Select the system design from among the promising alternatives that best meets the study's requirements

h) Prepare the final system specifications for the recommended systems design. Relate the systems design to other appropriate parts of the information system

i) Document the final design.

One of greatest contributions of following the above steps in systems design is that the right hand knows what the left is doing. The final step remains the selection of the equipment.

Self Check Exercise

1) Give the importance of the General Systems Theory in the context of information system design.

2) Enumerate and discuss the principles of a well-designed system.

Note: i) Write your answer in the space given below.

ii) Check your answer with the answers given at the end of this unit.

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2.3 SYSTEM DEVELOPMENT CYCLE

A system can be seen as a life-cycle that passes through a number of standard phases. In each of these phases, different management activities are involved. The basic phases of a system's life cycle are shown in the figure below.

Analysis → Design → Implementation → Operation evaluation → Decay → Replacement

The System Life Cycle

First an analysis should be conducted in order to establish system requirements and options available in system design. In system design a specific system will be developed to match the application. Implementation leads to operation evaluation during which the system fulfills its objectives and is modified from time, to time to reflect changes, if any, in requirements. With time the system becomes less effective, either due to any faults or because the system environment changes and the system is not able to meet its objectives. Thus, decay sets in and this calls for planning a new system. The final stage of the system's life cycle, thus, is its replacement.

The duration of each of these stages varies from system to system but the operation evolution phase is usually the longest, many times lasting a few years. The other stages like analysis usually last for a very short period. Rapid changes in the technology and the environment are the cause of the decay and eventually call for replacement of the system.

The various stages in system development are:

1) Definition of objectives
2) Definition of system requirements
3) Design phase
4) Implementation phase
5) Evaluation phase

Let us study each of these stages in detail.

2.3.1 Definition of Objectives

The first step is to engage in discussions leading to defining the objectives of any new system. This phase is valuable as it helps not only in evolving guidelines and requirements which may be invaluable later in the project, but also in commencing the communication process and ensuring that all points of view are considered. This phase should review established practices and procedures and attempt to identify where, when and why and how a change in system might be helpful. An initial conduct of needs analysis in cooperation with staff whose activities are going to be affected by any change is helpful.

The next step is to start gathering information on how to achieve the objectives identified in the first phase. This is basically about information gathering both from internal and external sources. This collected information should facilitate a decision about the type of system that is available to meet the requirements of the organization.

The definition of objectives therefore helps in establishing the terms of reference to be developed, initial needs analysis, evaluation of options and analysis of existing systems.

2.3.2 Definition of Systems Requirements

After having complete knowledge of the options available, and some insight into how the various solutions might be applied to meet the requirements in a specific application, it is necessary to go back and develop a full system specification. Usually this phase should seek to answer aspects like, the operations the system is likely to cover, regular users of the system, kind of information sought from the system, kinds of required records, vital features etc.

System Specification

The objective of the analysis phase of a systems analysis and design exercise is the establishment of the requirements for the system that is to be acquired, developed and installed. The analysis and logical design of a system can be summarized in a system specification, or specification of operational requirements. Usually such a specification will include:

— Background information about the organization

— Details of the facilities to be provided by a computerised system, identifying which are mandatory and which are optional

— Details of the environment in which the system will operate, including any standards, protocols

— The size of the system in terms of the numbers of records and transactions to be handled, the number of workstations

— A timetable for implementation of the system

— Mandatory questions to be answered by suppliers, such as size of the hardware, systems support arrangements, costs, etc.

— Information concerning any specific constraints

— Information about terms or forms of contract and any acceptance tests.

The system requirements specification sources both as a communication document, as it supports discussion and development amongst those concerned with the system, and also a reference document during implementation, maintenance and review.

2.3.3 Design Phase

The design phase is concerned with the analysis, flowcharting and other charting of the functions and operations that the system must perform. The design phase also includes the logical systems model, physical systems model, choice and ordering of hardware and software configuration.

2.3.4 Implementation Phase

This phase involves planning and preparation, education and training of personnel, database creation, system installation and switch-over from old system to the new system.

2.3.5 Evaluation Phase

The last stage of this exercise is a long way from the initial establishment of requirements, but after successful implementation it is necessary to complete the exercise by going back to the specifications and assessing the extent to which the system is meeting its stated objectives. This kind of assessment leads to improvements and refinements in the way in which a system is used or it may lead to decision for a new system. This phase also helps in maintenance and evolution.

Self Check Exercise

3) List the System specifications required in the system life cycle.

4) Enumerate of the stages in systems development.

Note: i) Write your answer in the space given below.

ii) Check your answer with the answers given at the end of this unit.

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2.4 SYSTEMS FLOWCHART

In each phase of the information system's development process the systems analyst relies on specific tools or techniques for accomplishing the goals and objectives. These include interview, questionnaire approach, observation, sampling and document gathering, charting on decision tables. Of these, charting is a technique which pictorially represents some dimension of the organization or an organizational activity. Of all the techniques utilized by systems personnel, charting is one technique most closely identified with systems efforts. Indeed it is not only an important fact finding technique but also a valuable one for performing analysis, synthesis and communication.

Amongst the most important of all charting techniques available to the analyst is the flowchart. A flowchart is a set of symbols representing an activity. Flowcharts are widely used in systems work because they can graphically represent the interrelationships among elements in a system to varying degrees of detail. Consequently, flowcharts can be used in problem definition, anlaysis, synthesis, communication and documentation. Three broad classifications of flowcharts are:

a) The *Systems Flow-chart* (as its name implies) is a chart which depicts the system as a whole with only subsystems or major elements shown.

b) The *Procedural Flowchart* is a graphic representation of a specific operation or data flow with the system.

c) The *Logic Flowchart* is the most specific of all the flowcharts. The intent of this type of flowchart is to provide an in-depth analysis of a given set of logical processing steps.

2.4.1 Flowcharting Symbols

For drawing flowcharts, a variety of symbols are used to represent certain logical or processing operations. The systems personnel for a number of reasons use these symbols:

— The symbols have specific connotations attached to them

— These connotations are standard among computer and technical persons, and

— These symbols can be drawn quickly

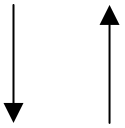
Although it is not necessary to use special symbols when flowcharting, the use of symbols can enhance the viewer's understanding.

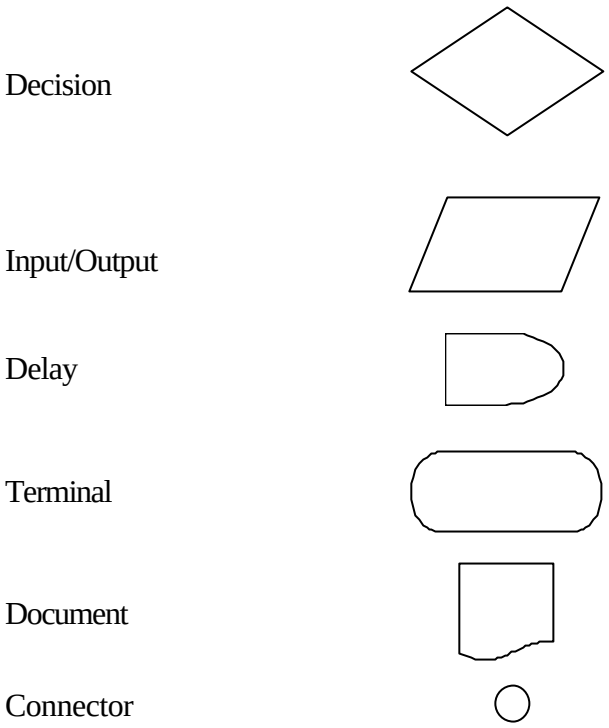
Some of the important flowcharting symbols are:

Flowchart Preparation

Process

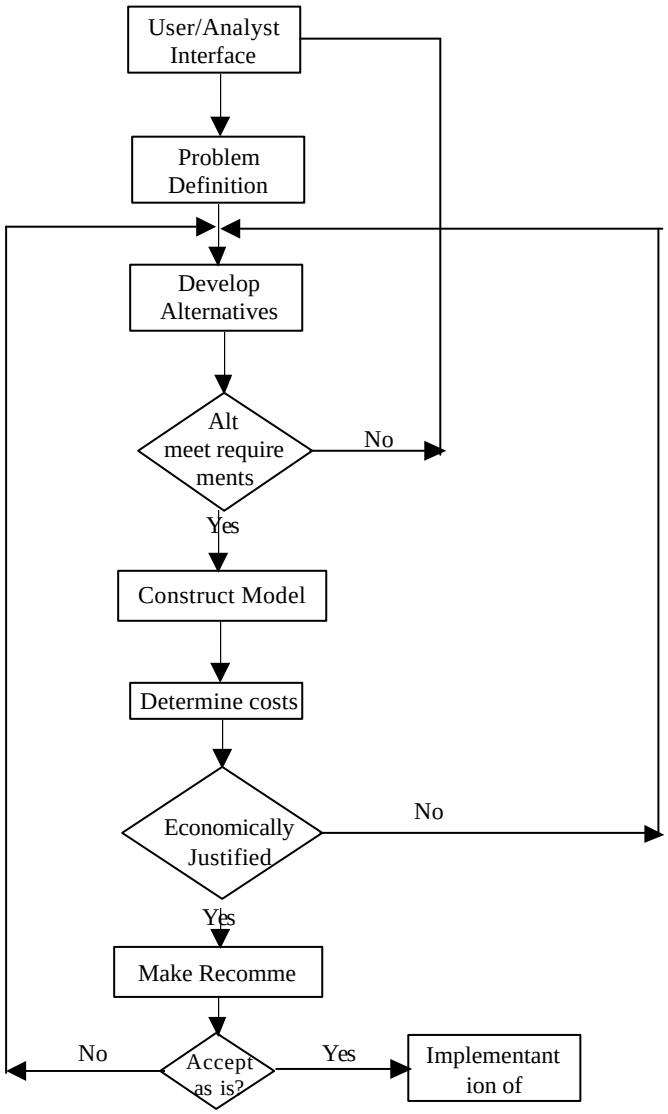
Flow lines





Flowcharting Symbols

Flowchart illustrating steps and process of systems analysis used in problem solving



2.5 SYSTEM IMPLEMENTATION

Implementation refers to the entire change effort associated with a new system. We design a system to improve information processing, and improvement implies that we must change existing information processing procedures. Implementation is the part of the process of designing a system and considerable time should be spent in planning the installation and implementation of the system. Implementation can be lengthy and it is important not to under underestimate the impact that the implementation of a new system may have on working practices and customer service. The installation phase starts with a review of the way in which the system will affect the existing operations of the organization. If a thorough analysis has been made in the earlier stages of the systems analysis exercise, many of the jobs, issues and other matters concerned with the installation of the system will have been identified and planned already. At this point it is necessary to gather a quantitative picture of the work to be done in order to achieve implementation and to identify specific staff responsibilities.

A detailed timetable of training, installation and other activities needs to be agreed and finalized. Implementation process involves:

a) **Preparation and planning the implementation**

Various preparatory activities involving a good understanding of the work necessary to implement the system design help in developing a detailed implementation plan.

b) **Installing hardware**

The system design is made available to the suppliers of the computing equipment contained in the approved configuration. This includes the computer itself and the various workstations, as well as other peripherals.

c) **Installing software**

After installation of the hardware, the software is to be installed, run and tested on small trial databases.

d) **Preparation of the database**

Once the hardware and the software start performing satisfactorily, preparation of the database commences. In some cases, it will be necessary to gather new data, and in others it will be necessary to reformat existing data to conform to the new system design. Once these tasks are completed, the data is entered into the database.

e) **Educating the participants and the users**

The new system will most likely affect many people. Some will make the system work. These are the participants, which include data entry operators, coding, and other administrative personnel. Others will use the system's output. All these people must be educated about their roles in the system.

f) **System conversion**

There are a number of implementation strategies that can be adopted for moving from one system to another. The options include:

— *Complete changeover* which involves the old system being replaced by a new system on a specified date. This is risky if the system is central to the organization's

operations and should only be contemplated if all aspects of the new system have been carefully tested and the changeover has been very carefully planned.

— *Phased approach*, in which the total system is divided into sections. Each section is installed individually and the sections are introduced one at a time. This approach allows staff to change gradually but on occasion there can be difficulties associated with maintaining parts of the old system, whilst introducing a new system.

— *Parallel running*, where both old and new systems are operated in parallel for is some period of time, until there is confidence in the new system and the old system can cease to operate. Although this is a secure approach, it is expensive and staff can easily become impatient at having two systems.

— *Pilot operation* of a system in a more controlled environment, such as a smaller department, before full introduction at all sites. Pilot running allows the system to be tested in operation in a controlled environment upon which systems staff can focus their support, as a means of testing the system before it is released system-wise.

Besides the above, three more types of conversions with which an analyst should be familiar are the equipment conversion, the data processing method conversion and the procedural conversion. Once the system has been implemented, the systems analyst plays the role of a consultant.

Self Check Exercise

5) Enumerate the four approaches to system conversion.

Note: i) Write your answer in the space given below.

ii) Check your answer with the answers given at the end of this unit.

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2.6 SYSTEM EVALUATION

System evaluation is the last stage of the systems analysis and design process. Although it is a long way from the initial establishment of the requirements, it is important to emphasise that after successful implementation, it is necessary to complete the exercise by going back to the specifications and assessing the extent to which the system is meeting its stated objectives. Such an assessment may lead to improvements and refinements in the way in which a system is used.

The evaluation process also includes testing of the equipment as systems analyst, while selecting equipment, must be aware of modularity, compatibility, reliability, maintainability and vendor support. Here, vendor support refers to availability of

training facilities; installation support; system development, conversion and testing assistance; experience level and competence; availability of a user group and availability of specialized software systems.

Evaluation helps to assess whether the operational characteristics of the sub-systems have been made compatible with interrelated subsystem and with the overall system. While evaluating, the effectiveness of the system can measured only after the following have been accomplished:

- Identification of user requirements at all levels of system design
- Measurement of subsystem and subsystem performance at all levels of operation.

The system user too dictates the criteria for evaluation. System effectiveness can be measured in terms of reliability, supportability, survivability, mobility, capability and dependability. Another aspect to be considered in evaluation is the costs both direct as well indirect. The various costs include the computer configuration costs, environment costs, physical installation costs, cost of conversion, cost of operations, programme and programme testing costs, training costs and documentation costs.

Self Check Exercise

6) Explain the need for system evaluation.

Note: i) Write your answer in the space given below.

ii) Check your answer with the answers given at the end of this unit.

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2.7 SYSTEM DOCUMENTATION

System analysts and users usually develop procedures concurrently with module coding and testing. A complete written set of manual procedures is developed by documenting all manual processes to be performed by the user and data processing personnel in the actual operation of the system. The procedures cover such items as input preparation, control and balancing, error correction, and computer operator instructions. Collectively, these procedures form a critical part of the system's documentation.

Documentation is sometimes the most neglected aspect of the systems development life cycle. Organizations frequently depend on a key individual or group of individuals to design and operate an information system. If these people rely on their memories for programming, systems and operating information and leave the organization for some reason the organization has to study and document the existing system before

work can begin on modifying it or designing a new one. Rarely anyone remember all the detailed design information of a complex computer information system.

Adequate system documentation includes the following:

- All the specifications in the systems development life cycle
- Data flow diagrams and structure charts
- Data dictionaries
- Hardware specifications
- Performance specifications
- Joy descriptions
- Procedure manuals

A successful documentation programme requires goals and procedures for creating and updating documentation. Some specific goals include a simplified yet comprehensive method for creating and updating documentation; a standard development of a manual whose format and organization would be a model for all documentation and a standardized approach to documenting all systems.

Self Check Exercise

7) List the kinds of system documentation required in organizations.

Note: i) Write your answer in the space given below.

ii) Check your answer with the answers given at the end of this unit.

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2.8 SUMMARY

The system design brings together the separate elements into a viable whole and by doing so shows how something can be accomplished. Knowledge required to perform the design phase encompasses the organizational resources, user information requirements, system requirements, data processing methods, data operations and design tools.

An important aspect of the overall design of an information system is the establishment of effective controls. During the design phase, the systems analyst must identify and implement various controls to ensure the integrity and reliability of the information system. Specific design activities necessary for the development of an information system too are to be considered.

A frequently used tool for a systems analyst while designing a system is a flowchart. Flowcharts are widely used in systems as they can graphically represent the interrelationships among elements in a system to varying degrees of detail.

Evaluation of a system helps an analyst to decide the merits of a system before its actual implementation. In order to implement a new system successfully, there are a few activities to be performed by the systems analyst. These include training and educating personnel, testing of the system, system conversion and finally a follow-up to implementation.

2.9 ANSWERS TO SELF CHECK EXERCISES

1) The General Systems Theory and the importance of each one is discussed below:

General Systems Theory	*Importance in information system design*
a) Components of a system interact.	Delineate components and their interrelations during analysis.
b) A system is a whole.	Be sure to define the entire system before examining subsystems.
c) Systems are goal seeking.	What is the goal of an information system ?
d) Systems have input and output.	A major design task is to specify input and output.
e) Systems transform input to yield output.	A major design task is to specify processing to Produce output from input.
f) Systems yield entropy.	Information processing is critical to an organization's success.
g) Systems must be controlled.	Information systems help control the organization, information systems have to have feedback on their own performance and be controlled.
h) Systems form a hierarchy.	Information systems design is a hierarchical task, systems consist of hierarchies of subsystems.
i) Systems exhibit differentiation.	Information systems have many specialized parts.
j) Systems exhibit equifinality.	There are many ways to design a system to achieve desired goals.

2) The principles leading to the development of a well-designed system are:

   — Principle of acceptability

— Principle of enhancing the decision-making process

— Principle of economy

— Principle of flexibility

— Principle of reliability

— Principle of simplicity

3) The system specification usually includes:

— Background information about the organization

— Details of the facilities to be provided by a computerised system, identifying which are mandatory and which are optional

— Details of the environment in which the system will operate, including any standards, protocols

— The size of the system in terms of the numbers of records and transactions to be handled, the number of workstations

— A timetable for implementation of the system

— Mandatory questions to be answered by suppliers, such as size of the hardware, systems support arrangements, costs, etc.

— Information concerning any specific constraints

— Information about terms or forms of contract and any acceptance tests.

4) The stages in the systems development are:

a) Definition of objectives

b) Definition of systems requirements

c) Design phase

d) Implementation phase

e) Evaluation phase

5) There are a number of implementation strategies that can be adopted for moving from one system to another. The options include:

a) *Complete changeover* involves the old system being replaced by a new system on a specified date.

b) *Phased approach*, in which the total system is divided into sections, each section is installed individually and sections are introduced one at a time.

c) *Parallel running,* where both old and new systems are operated in parallel for a period of time, until there is confidence in the new system and the old system can cease to operate.

d) *Pilot operation* of a system in a more controlled environment, such as a smaller department, before full introduction at all sites.

6) The system evaluation is a stage of the systems analysis and design process. For successful implementation, it is necessary to complete the evaluation exercise

by going back to the specifications and assessing the extent to which the system is meeting its stated objectives. Such an assessment may lead to improvements and refinements in the way in which a system is used.

7) Adequate system documentation includes the following:

- All the specifications in the systems development life cycle
- Data flow diagrams and structure charts
- Data dictionaries
- Hardware specifications
- Performance specifications
- Joy descriptions
- Procedure manuals.

2.10 KEYWORDS

Flowchart : A flowchart is a set of symbols representing an activity. Flowcharts are widely used in systems work because they can graphically represent the interrelationships among elements in a system.

Systems Analysis : It is the study of an existing system for the purpose of designing a new or improved system.

Systems Approach : It is a philosophy of structure which coordinates, in an efficient manner, the activities of an organization or a system.

System Conversion : It is a changing process from one system to another and occurs when the old system is completely abandoned upon implementation of the new system.

System Design : System design is the determination of the processes and data a new system will require. When the system is computer-based, the design can also include a specification of the types of equipment to be used.

System Development Life Cycle : The complete process from planning, analysing, then designing and then implementing the computer processes.

System Documentation : Documentation is a comprehensive documenting method for creating and updating and maintaining the system a standards manual whose format and organization would be a model for all documentation to be developed; and a standardized approach to documenting all systems.

System Evaluation : It is the process that helps a systems analyst decide the merits of a system before its final implementation and also assess the performance of the system from time to time.

System Implementation : System implementation is the acquisition and integration of the physical and conceptual resources that produce a working system.

System Life Cycle : The stages to first plan, then analyse, then design and then implement the system.

2.11 REFERENCES AND FURTHER READING

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