2
SYSTEM CONCEPTS

A system is a group of interrelated components working together towards a common goal, by accepting inputs and producing outputs in an organized transformation process. The interrelated components which are systematically arranged to form a system are called subsystems. In simple words, system is a set of elements which operate together to accomplish an objective. Systems may be physical, like the sun and its planets; biological like the human body; technological, like an oil refinery; and socio-economic, like a business organization. System concepts underlie the field of information systems.

Definition of a System

System can be defined as a group of interrelated or interacting elements forming a unified whole. It may be either physical or abstract. An abstract system is an orderly arrangement of interdependent ideas or contracts. But a physical system is defined as a set of elements which operate together to accomplish a goal; it is made up of objects such as land, building, machines, people and other tangible things. A system can also be understood as an organized or complex whole, an assemblage or combination of things or parts forming a complex or unitary whole.

Characteristics of a System

The characteristic features of a system enable us to distinguish it from various subsystems. The important features are:

(i) Orientation towards the objective: A system is an assembled set of elements, acting together to accomplish a common goal, purpose or objective. The subsystems are oriented towards the common objective of the system and they interact in order to achieve the objective.

(ii) Structure of the system: The component parts of a system are arranged in a systematic manner, according to a specific design, and each of them has definite function to perform in the system. The structure of the system deals with the design of components in a particular arrangement.

(iii) Inputs: Inputs for a system involve elements that enter the system to be processed. They include raw materials, energy, data, information and human efforts.

(iv) Processing of inputs: It is the process of transformation through which inputs are converted into outputs, for instance, manufacturing process, data calculation etc.

(v) Outputs: They are the result of the transformation process, like human services, finished products, etc.

(vi) Interdependence: The components of a system are interdependent. They interact with each other to achieve the common goal. The subsystems cannot exist in isolation; they are interrelated and the function of one would depend upon the function of another.

The general model of a physical system is input, process, and output.

The model of a simple system can be illustrated as:

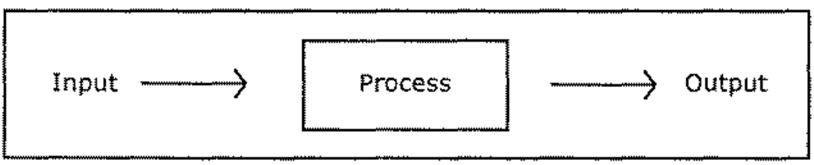

Fig. 2.1: General model of a system

In case a system involves a number of inputs and outputs, its model can be represented as:

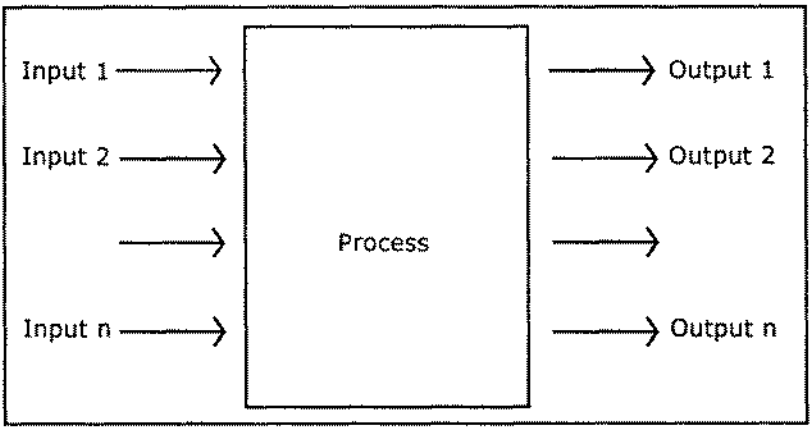

Fig. 2.2: Complex system

The features, which define and delineate a system form its boundary. The system is inside the boundary, and the area outside the boundary is called the environment. Each system is composed of subsystems, which in turn are formed by various other subsystems. The interconnections and interactions between the subsystems are called interfaces. A subsystem at the lowest level is termed as a black box. The hierarchy of systems can be represented as:

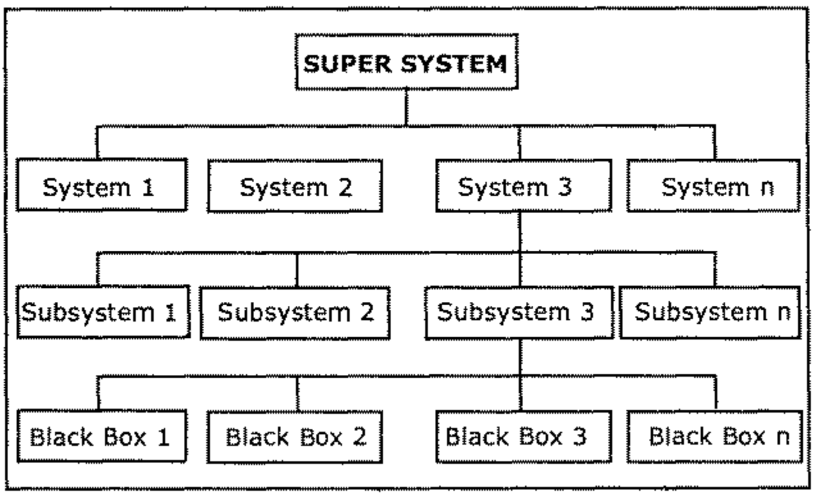

Fig. 2.3: The hierarchy of system

Types of Systems

The important system classifications include:

(i) Conceptual and empirical system: Conceptual systems deal with theoretical structures which may or may not have any counterpart in the world. They are composed of ideas. They are typified by those of science, such as economic theory, the general system of relativity etc. These are systems of explanation or classification. They may also take the form of plans, policies, procedures, accounting system, etc.

Empirical systems are concrete operational systems made up of people, machines, materials, energy, and other physical things. Electrical, thermal, chemical, and other such systems also fall under this category of systems.

(ii) Permanent and temporary systems: Systems enduring for a long time span, in relation to the operations of humans in the systems, are called permanent systems. Temporary systems are designed to last for a specified period of time and then to dissolve. They are important for the accomplishment of specific tasks.

(iii) Natural and manufactured systems: Natural systems are found abundantly in nature, like solar system, water system etc. They originated from nature itself and are not the result of any human effort.

Manufactured systems or artificial systems are formed by human efforts. Transport system, communication system, etc. are examples.

(iv) Deterministic and probabilistic systems: In deterministic systems, the interaction among the parts is known with certainty. It operates in a predictable manner. It is possible to predict the outputs accurately, if a description of the state of affairs at a particular point of time plus a description of the inputs and the operation is available. A computer programme which performs exactly according to the set of instructions is an example of a deterministic system.

The probabilistic system is described in terms of probable behavior. The output can be predicted only with a certain degree of error. In such a system, we can predict the results but the exact values of these results at a given time are not known. For instance, in an inventory system, we can predict the average time taken to get the material, average demand, etc., but the exact values cannot be calculated.

(v) Subsystems and super system: Smaller systems within the system or the components of a system are called subsystems Super system is the whole complex of subsystems, or it denotes any extremely large and complex system.

(vi) Stationary and non-stationary systems: A stationary system is one whose properties and operations either do not vary significantly or vary in a repetitive manner. The automatic factory, super market operations, etc. are examples.

In non-stationary system, the properties and operations are subject to variations at a faster rate, for instance, the human being, research and development laboratory etc.

(vii) Open and Closed system: Open systems interact with their environment exchange information, and material energy with it. Open systems adapt themselves to the changes in environment so as to continue their existence. All living systems are open systems. Cells, plants, human beings, etc., are examples of open systems.

A closed system is a self contained system. It does not exchange material information or energy with its environment. For example, chemical reaction in a sealed and insulated container is a closed system.

(viii) Adaptive and non-adaptive systems: A system, which reaches out to its environment in such a way as to improve its functioning, achievement or probability of survival, is called an adaptive system. Most biological systems are adaptive systems.

A system which does not change with changes in the environment is called a non adaptive system. It is free from environmental influences and may degenarable eventually.

(ix) Social, people-machine, and machine systems: A social system is a system purely made up of people. Examples are business organizations, Social clubs, etc.

People-Machine systems use both people and equipment to achieve the goal. Information system is an example of people-machine system. Pure machine systems are made up of machine only. They have to obtain their own input and maintain themselves. Electric power generating system is an example of a pure machine system.

Subsystems

Management Information System has several subsystems, which are interdependent and interrelated. Each system is made up of a number of smaller units, which came to be known as subsystems. Each subsystem may have many inputs and outputs. A number of interconnections are required among these subsystems to exchange inputs and outputs. The number of interconnections in a system can algebraically represented as: $\frac{1}{2}N(N-1)$,where N is the number of subsystems . If in a system there are 10 subsystems, then the number of interconnections in this system is 45. The use of subsystems as building blocks is basic to analysis and understanding of the principles, which determine how systems are built from subsystems.

The subsystems with in Management Information System are:

(i) Computer system: It includes the hardware, the operating system, and the software.

(ii) Management: Management system as a subsystem of MIS includes the managerial tasks relating to the effective functioning of the organization. It covers planning, control and coordination of human resources development etc.

(iii) System engineering: This involves system design and development as well as system maintenance.

(iv) Application: The application subsystem includes various application systems which are developed and implemented, to produce the desired outputs.

Factoring (Decomposition)

The process of dividing a system into lower level subsystems is called factoring of a system or decomposition of a system. A complex system is difficult to understand and evaluate, when it is considered as a whole. Hence, it is decomposed or factored into various subsystems. The boundaries and interfaces are clearly defined so that the sum of the subsystems constitutes the entire system. The factoring process is continued until the smallest subsystem of manageable size is obtained. The decomposition of an information processing system into various subsystems like production subsystem, finance, purchase, marketing and personnel subsystem is an example of factorization. The factoring process is continued until the smallest subsystem is manageable easily. Finance subsystem can again be divided into imprest cash maintenance subsystem, general ledger maintenance subsystem, bank transation subsystem, etc. The question of how to factor the system and where to mark the boundary is answered on the basis of the objectives of decomposition and also on the basis of individual differences among designers. The general principle followed in decomposition, is known as functional cohesion. According to functional cohesion, components are considered to be the part of the same subsystem if they perform, or are related to, the same function. After identifying the functionally cohesive subsystems, the boundary needs to be defined, specified interfaces to be simplified, and appropriate connections to be established among various subsystems.

Simplification

Factoring leads to a large number of subsystem interfaces. Each interconnection is a potential interface for communication among the subsystems. Each interface implies a definition of a communication part. In simplification, subsystems are arranged in such a way as to reduce the number of interconnections. There are two methods of simplification. They are:

(i) Methods are established for decoupling systems in order to reduce the need for interconnection:

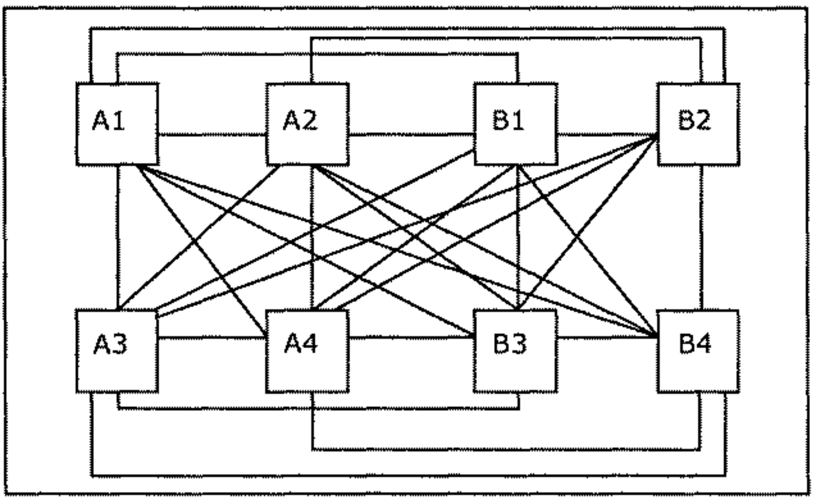

Fig. 2.4 : Simplification

Number of interfaces = ½ N (N -1) = ½ x 8 (8 -1) = 28

(ii) It is possible to establish clusters of subsystems (which interact with each other) and a single interface path is defined from the cluster to other subsystems or clusters.

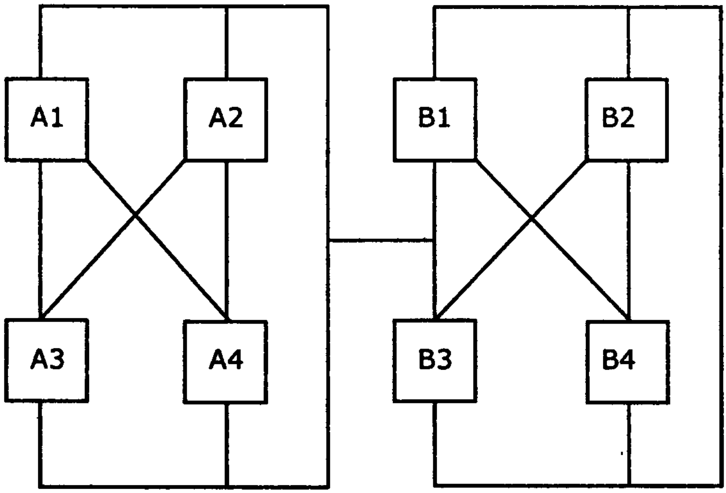

Fig. 2.5: Cluster of system

Decoupling

The components of a system constantly interact with each other, to exchange inputs and outputs. If the connection between these subsystems is very tight, close co - ordination is necessary for the smooth functioning of the system. In other words, exact matching of output of one subsystem with the input of the next subsystem requires detailed planning and co-ordination. But it is very difficult to arrange for such kind of close co-ordination. If raw material is directly put to the production subsystem, when it arrives in the organization, it is said to be tightly coupled. In such a situation, the timing of raw material supply should be precisely arranged in order to avoid delay in production and to prevent the early arrival of materials, which may cause storage problems. The problem of tight coupling can be solved by decoupling the subsystems. it means that the connection between subsystems is loosened or decoupled so that the two subsystems may operate in the short run with some degree of independence. Decoupling may be in the following ways:

(i) Maintaining inventories, buffers, or waiting lines,

(ii) Use of stock and flexible resources, and

(iii) Maintenance of standards for all subsystems at all times.

Decoupling ensures flexibility and independence and may encourage self-reliance in individual subsystems.

Control in Systems

A control mechanism is essential to ensure the proper working of a system. Feedback process is the control technique used in systems to achieve this purpose, which is provided through information systems. Feedback process involves comparison of actual output with the standard and sending of inputs to compensate for the difference, and to confirm the output to the standard.

Feedback Loops

Feedback is defined as the return of part of output of a system into the input for the purpose of modification and control of output, as in electronic amplifiers, automatic machines, etc. Control is exercised in organizational systems with the help of information feedback loops. The feedback may be either positive or negative.

Positive Feedback Control

Positive feedback control causes the systems to repeat or amplify an action. It acts in the same direction as the measured deviation. If advertisement expense brings more sales than the targeted sales, positive feedback is said to be caused. Control technique with the help of positive feedback is called positive feedback control.

Negative Feedback Control

Feedback, which tends to reduce fluctuations around a standard, is termed negative feedback. The corrective action would be in the opposite direction to the deviation. It tends to smoothen the fluctuations and enables the system to confirm to the norms and standards. Negative feedback control can be represented as follows:

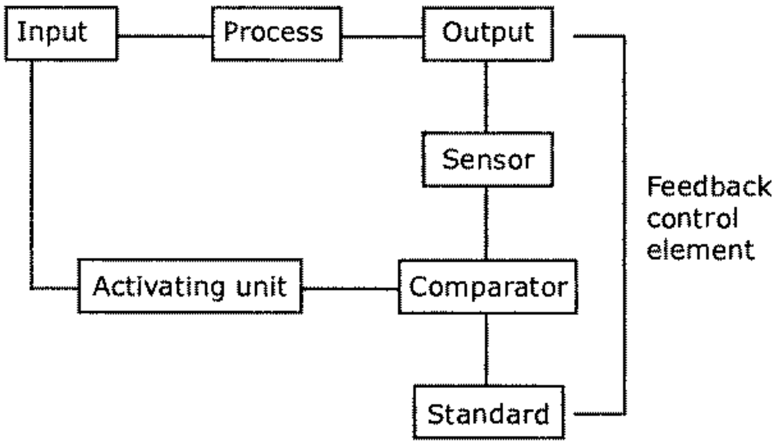

Fig. 2.6: Negative feedback control

Feedback is the key to system control. The control system can be divided into three categories. They are:

(i) Closed loop system: It is a system where feedback based on output measurement is used to make appropriate alterations to the input. When the stock level control system has planned level of stock for each item, the actual stock level of each item is measured and compared with the planned level. Adjustments are made to bring stock levels up or down to conform to the planned level.

(ii) Open loop system: They are systems where there is no feedback loop and where the control is external to the system. Control action in an open loop system is not automatic, and may be made without monitoring the output of a system, for example, a heating system without an automatic thermostat. Control may be exercised externally by turning it on and off at appropriate times.

(iii) Cybernetic system: Cybernetics is the science of communication. Control systems embodying feedback control are commonly called cybernetic systems. In the strict sense, the term is used for denoting complex probabilistic self - regulating systems.

Law of Requisite Variety

This Law, propounded by Ross Ashby, states that complete control of a system can be achieved only when the control system has as much variety in response as the number of control should have an appropriate response to each control situation. The law argues that the controller of a system must be able to determine variations of control variable, and to introduce system change instructions for such change. The law means that, for a system to be controlled, every controller must be provided with:

(i) Adequate control response,

(ii) Decision rules, and

(iii) Authority to self - organize the system.

System Concept Applied to Information System Design

The basic system model of input, process and output is applicable in the case of information system also, since it receives input of data and instructions process them and produces the outputs. The system concept is used in designing, implementing and maintaining the information system. Information system design uses the structured design approach, which requires delineation of subsystems and setting up of interfaces. As seen in systems, information system has the following features:

(i) Input,

(ii) Output, and

(iii) Subsystems.

The functional subsystems of an information system consists of a hard ware system , the operating system, the communication system and the database system,. It also includes application subsystems, such as order entry, billing, payroll, and personnel. The significance of the system concept is not only applicable at the time of system introduction or implementation, but is also useful to understand system for further modification, i.e, each application or subsystem is analyzed in terms of input, storage, processing and output.

Control in Information System

Management Information System provides extensive support to management in the planning and control activities. The plans set the standard for achievement. The system measures and compares actual achievement with the standard. The differences are analyzed and the reasons are identified, for managerial control. The performance is monitored by the information system on a continuous basis, and is reported to the management on an exceptional basis. The control process in information system may be of three types:

(i) Input control: The general model of any system consists of three elements input, process and output. While exercising control in an information system, the first area to be concentrated on is the input. Control of input is essential for the proper utilization of the input (where it is energy, material, information, etc).

(ii) Process control: The process through which the input is converted into output also needs to be controlled. All the activities undertaken while transforming the input into output must be controlled to ensure the effectiveness of the processes.

(iii) Output Control: It involves the control of the results of a particular course of action. Output can be controlled by comparing the actual output with the targeted output, and then by representing the deviations, if any to take corrective action.

Conclusion

System concept is one of the modern approaches to complex phenomena, whose focus is on the whole, though it is made up of components. The concept is highly significant in information systems. A system does not exist in a vacuum. If functions in an environment involving other systems. Information system can play a major role in support of strategic objectives of an organization, which provides a firm with competitive products and services that give strategic advantages over its competitors. This alone can reinforce a firm to survive and succeed in the long run in the market.

Exercise

Short Answer Questions

1. Define a system.
2. What are the features of a system?
3. Explain the general model of a system.
4. Explain the concepts of subsystem and supra system.
5. Write short note on conceptual and empirical systems.
6. What do you mean by deterministic and probabilistic system?

7. Describe open and closed systems.
8. Distinguish between open system and adaptive system.
9. Define a temporary system with example.
10. What are the subsystems with in Management Information System?
11. Define factoring or decomposition.
12. What do you mean by simplification in information system and how can it be attained?
13. Discuss the concept of decoupling.
14. Explain briefly control in systems.
15. What are feedback loops?
16. Compare and contrast positive and negative feedback control.
17. Explain the classification of feedback control systems.
18. Describe the law of requisite variety.
19. Explain system concept.
20. Describe control in information system.

Essay Questions

1. Narrate the system concept applied in information system design.
2. Discuss various types of systems.
3. Explain the concepts of decomposition, decoupling and simplification.