FOUNDATIONS OF INFORMATION TECHNOLOGY

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CONCEPTS IN INFORMATION AND PROCESSING

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1 CONCEPTS IN INFORMATION AND PROCESSING

1.1 INFORMATION TECHNOLOGY

The last decade in the global arena has witnessed a tremendous growth in the area of information technology. Rapid advances in the technologies for communication media like television, computer, internet, printing and publishing has enabled us to get prompt access to required information. The computer is the most versatile machine man has ever made. The use of computer at home has become a reality and the use of computers at work is very common. Now almost all the government departments and commercial organizations have accepted the computer as a major tool to renovate their function. Computers are being used in multiple areas ranging from solving intricate scientific problems to art, cultural, historical, accounting, financial, medical and even domestic sectors. Truly, with Information Technology, the computers has made a significant impact on all dimensions of our day to day life, e.g. reservation of air and railway tickets, buying and selling items on Internet, electronic market, bank transaction on net, entertainment, education, communication, hotel reservations and so on. Information Technology has replaced the conventional methods to solve technical and operational problem by introducing a much faster and more convenient method which is based on its ability to access large and complex pools of data.

Initially computer could process information contained in the form of text only. A text is written with letters, digits and other characters which you can read. Later it was also realized that the information contained in form of images, animation, audio, video can also be processed. Imagine, if you have to create a database of your friends for future references, you will have to create the database using attributes like Name, Date of Birth, Father Name, Telephone No., Street, City, Pin Code etc. Just think, how good it would be if you could store the image of your friend, his voice or video clip in which he is seen to your database. The pressing demand for storage and retrieval of data represented in multiple forms like Text, Image, Animation, Graphics, Audio, Video has given a new direction to computer scientists and technologists to process information stored in multiple formats. All this has revolutionized information technology.

Information Technology is a generic name for the following functions:

1. Information/Data Representation
2. Information/Data Storage
3. Information/Data Retrieval and Processing
4. Information/Data Communication

The computer is as a tool to do the above mentioned tasks effectively, efficiently and extremely quickly.

1.2 AN OVERVIEW OF CURRENT INFORMATION TECHNOLOGY APPLICATIONS

Among the fundamental computer applications are processing, storage and retrieval of information and developing effective technologies for communicating the information represented in various formats. The information may be contained in form of text, image, graphics, audio, video or animations. An important application is Video on Demand. The video on demand is very common now-a-days. The cable TV operator provides services to watch any video clipping, movie or any favorite TV program. The channel is established from the computer at home and the cable operator. You may surf the TV program and select any program of your choice by selecting the appropriate program on your computer. In such cases, the compressed video is transmitted over the communication channel, usually the cable, and is decompressed on your computer while playing. All video cassette player functions are provided at your computer to record, play, forward or rewind. Another important application is multimedia conferencing. It is now possible to arrange meeting between several executives when they are not physically present at one place. Using current technologies, a group of persons can talk and discuss with each other as though they were present in one room. Anybody who will speak will be listened by everybody. This is achieved using a underlying high bandwidth channel which is able to transmit the video data at an extremely fast rate.

Applications like home shopping or shopping on web, knowing the details of the items to be purchased in the form of images, graphics or video are very common today. All healthcare systems using Telemedicine or Geographic Information System require a high bandwidth as in all such cases it is necessary to communicate video or graphics. The information contained in any format other than text requires high storage capacity. Storage, retrieval and processing of such information is a costly affair because of two reason, namely, lack of bandwidth and lack of effective tools and technologies to handle such large information.

Apart from the applications described above, the Information Technology concepts are being used in business applications ranging from inventory control, preparation of various business documents like invoices, pay bills, salary statements, issue/dispatch transactions, accounting and financial management, account wise consumption, analysis report, sales report etc. There exist number of special purpose business system developed to meet the specific requirement of a company or business. Central to these software packages are modules to handle human resource, invoices, accounting etc. The requirement to bring all the activities of a business organization under single software has led to the development of ERP systems. The Enterprise Resource Planning (ERP) systems are bundle of the software which includes the standard business practices. These softwares are customized according to the need of an enterprise and provides the tailored solution to the enterprise. Information Technology is playing a significant role in standardization of different processes in banks. Banking has taken a major lead in past few years after deploying the Information Technology. Now it has become possible to transfer the balance, internet banking, Tele-services and using automatic tailor machines. Time, effort and money required to monitor the business processes in the banks has been reduced drastically in past

few years. EDI (Electronic Data Interchange) has allowed the different automated/computerized organizations to transfer the documents electronically. EDI has reduced the cost of transportation, reduced paper work, minimum human interaction and faster exchange of the document within the organization. This is not all, Information Technology application to different areas such as hospitals, medicine, reservations, tele-shopping, manufacturing, communication etc., are very common. The process of updating the conventional practices through Information Technology in the different organization is still going on.

1.3 WHAT IS THE DIFFERENCE BETWEEN DATA AND INFORMATION ?

It is generally not easy to decide as to when a particular piece of text, numbers, tables, images, graphics serve as merely data and when they become information. In fact, there is no hardline to tell us that a piece of text or sample of numbers represent data or information.

Let us take an example. The government has launched a polio vaccination drive to eradicate polio from India. In this programme, officers or executives at different levels have been deployed. The top level of executives monitor the overall progress and might be interested about the success at the national level. Similarly, the next level of executives watches the progress at the state level, the next at the zonal, district, block and village levels. The top level has fixed a target that vaccination of a certain percentage of population at the national level be achieved. To monitor the overall progress at a particular time, the top level collects the data from each state and process that data to know the current status. Similarly, at State level, data are collected from Zones and processed subsequently. Data from lower levels are collected and processed to find the current status at the upper level. The result of processing of data at each level serve as **information** at the next higher level. For example, suppose there are 100 villages in a particular block. If executives at block level are provided with vaccination data of all one hundred villages, then it will probably not be of much importance. However, if after processing of all such hundred data, if the average percentage of vaccination at block level is obtained, then this figure will be of much importance to executives at the block level. The executives at block level then may take decisions based upon the figure obtained after processing the data. This processed figure thus serves as information at the block level.

The data are the basic facts and figures which may be used as a historical record about say, a company or an organization. These may be assembled together in the form of files, reports, graphs, payrolls etc. If raw data is processed as par certain rules or policy, the results obtained (if they are meaningful) are called information. The word meaningful here signifies that on which executives or the management may take decisions. It may be noted that information obtained at a certain level may serve as raw data for further information at another level. That is probably the reason that data and information words are used interchangeably. Strictly speaking, data consists of numbers, text etc. that a computer processes according to certain procedures to produce information. The computer can be used to organize the raw data in some order so that it becomes information. Preparing charts, tables, reports, work sheet etc. are examples of creating information from raw data.

We may therefore conclude that processing data is a cyclic process and at every hop we receive more meaningful data as evident from Figure 1.1.

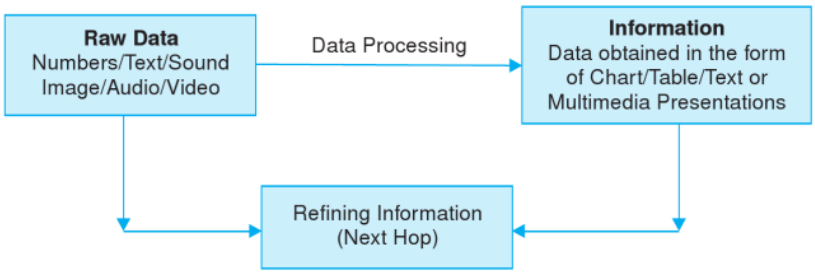

Figure 1.1

1.4 INFORMATION SYSTEM

The past decade has witnessed tremendous growth in the information innovation and application. Information Technology has become a vital component for the success of business because most of the organizations require fast dissemination of information, information processing, storage and retrieval of data. Today management of an organization involved in the business requires high speed processing of huge amount of data, fact and figures. High speed communication between organization, customers, clients etc. is also playing an important role to achieve high business goal. These requirements of modern business led to development of a business information system which provides appropriate information to appropriate person in desired format and at correct time. The timely processing of data also helps and enable management to take important decision at earliest possible time. **Information System** may be defined as organized collection of human, software, hardware and communication equipment and database, in which the person controls, process and communicate the information. The overall objective of the Information System is to gather the data, processing of data communicating the information to the user of the system. User group includes the person from all level i.e. top, middle and operational level. The information obtained from the information system allows the different persons to take decisions. To provide the appropriate information to user, it is necessary to collect the data, process and output of the data. Information System may include feedback mechanism under which processed data or output are fed back to the system to make changes in processing activities. **For example**, sales, inventory report generated may be fed back to appropriate managers to take appropriate decision in time. Therefore, the high end information systems are designed around feedback and control machanism, based on user-based criteria to produce and communicate the information for planning and control of business.

Information System may be broadly categorized into two categories (i) Manual (ii) Computer Based Information System (CBIS). As discussed before, the major objective of the information system is to collect, process and disseminate the data to appropriate user. Traditionally, the business analyst in the organization study the pattern of investment, expenditure, sales etc. to evaluate the performance and to take decision for future. These analyst used to collect the data and prepare the report in the form of chart, table, graph etc. to analyze the business. Now-a-days, the requirement of a business analyst may be programmed and a computer based system may be developed to study and analyze these reports. These Information System are called Computer based Information System. **For example,** in earlier days the rail reservation system was manual. Traveller used to fill application form and allotment of seat in different quota on different train. These reservation used to be on the basis of certain well defined rule. After the introduction of the computer, these rules and guidelines have been programmed

in computer along with the required software that has emerged as reservation agent. We may say that the Information System existed previously but it was manual. The new Information System, which used computer as central component, is known as computer based Information System.

Basic components of a computer based Information System are:

1. Users
2. Hardware/Communication Equipment
3. Software
4. Database
5. Set of Methods

1. Users: are one of the most important components of the Information System. These users include the different group of persons who manages the system and those who retrieve the information from this system take decisions.

Another set of the users are those who not only retrieve the information but also provide the information to information system. **For example,** marketing and sales personnel provide the details of sale etc. to the Information System.

2. Hardware/Communication Equipment: In the modern business, it is not only necessary to gather and process information but the fast dissemination of the information is also essential. Lot of organizations maintain constant touch with a large customer base. It requires that the Information System at an organization must be computer network enabled and must be able to communicate the information through internet or other communication channel. All hardware, Network and communication equipment forms an important component for a computer based information system.

3. Software: A software is a collection of programs, which do a specific tasks. Different rules, methods and practices prevailing in a business organization are coded into the programs or software. The software once installed in computer system is considered as most important component of information system. These programs process the data and generate report such as sales report, invoice, bill etc. for customers and generate different reports for the managers.

4. Database: Database is a structured collection of data. The software or programs fetch the data from the database and process them as per the requirement. The database may contain the customer and employee record, data pertaining to sales, inventory, account etc. The raw data gathered from the field by sales or marketing persons, from customer etc. are stored in the database. To develop an efficient Information System, it is necessary to have a good design of database. The Information System are said to be built on top of database and performance of Information System depends on the underlying database.

5. Set of Methods: Set of methods is another important component of Information System. The set of methods refers to the tradition and practices prevailing in the business house where the Information System is used. Various traditions, practices, which govern the business, are laid down in the form of rules which are then coded into the programs. These rules or methods changes from time to time whenever any new business practice is adopted or any change in the business environment is observed. The Information System must be adaptable to these changes and must be flexible to incorporate the changes in the business environment.

1.4.1 Types of Information System

Following are the motivating factors for any business enterprise to use information system:

1. Information System's support for business processes and practices.
2. Information System's support for decision making.
3. Information System's support for the innovative planning.

Depending upon the specific requirement of users, various types of information systems may be developed. Based on the specific requirement of organization and need of user, information system may be categorized into the following categories:

1. Transaction Processing System
2. Management Information System
3. Work Flow System
4. Decision Support System
5. Expert System

1.4.2 Transaction Processing System (TPS)

A transaction processing system is a traditional system which is combination of people, software, hardware and database. The main focus in these systems is on completion of a business transaction. The objective of these systems are to reduce the cost, effort and automation of business activities in the organization. **For example,** business transcations in an organization includes activities like raising an invoice, acceptance of sales order, receipt and dispatch of item from store etc. A business transaction is considered as an atomic activity. It is therefore necessary to complete the business transaction otherwise the underlying database may enter into inconsistent state. Suppose, a sales order is received by an organization from a client, after the receipt of sales order a chain of activities needs to be invoked. These involves, informing manufacturing unit to raise requirement of items, sales department, accounts, shipping etc. If any of the related activity is not completed, required modification to the database may not occur. This situation may lead disaster because incomplete or inconsistent information may jeopardize the business activity. The nature of these transactions may vary from one organization to another. The information system processes these transactions as a basic activity which satisfies the organizations day to day need. There may exit a number of transactions in the organization which need to be completed for full assistance of persons working at operative level and top management. These systems ensure timely and correct completion of the job. A transaction processing system deals with the transaction in two different ways.

1. Batch Processed Information System
2. On Line Transaction Processing (OLTP)

In the **batch processing**, the different transactions are queued and they are executed one after another. These transactions keep modifying the data or database and preceding transaction operate on the data processed by previous transaction. Payroll system, electricity billing, telephone billing are examples of batch processed system. These activities are triggered at required time and result in fetching the data from the database and prepare the reports like marksheets, telephone bills etc. These transactions also modify the database when required. The **On Line Transaction Processing System** (OLTP), in contrast to batch processing, process the data instantaneously. The OLTP systems are becoming more popular now-a-days as they provide instant services to customer. The request raised by either customer or any other person are instantly (on line) processed by the computer. Good example of OLTP systems are railways reservation system banking system etc. However, OLTP, requests are processed instantaneously whenever they are submitted. The OLTP is the system in which operational level support to organization is provided by processing the data through business transactions. These requests retrieve and store the data in database on line. Any failure in these systems might become a costly affair, as recovery from the failure is time consuming and an intricate affair. There exist another type of transaction processing called Real Time Transaction Processing. In **Real Time Transaction Processing** System, not only transactions are processed on line but also the deadlines are maintained.

In the mission control operation, it is not only important to process the data but it is more of importance that the transactions are completed within deadline.

1.4.3 Management Information System (MIS)

On Line Transaction Processing Systems provide the operation level support to the organization by processing the data through business transactions. These business transactions are submitted to the system time to time. MIS is used in those organizations, where information in form of reports, presentations is required by the management to take decisions. The Transaction Processing Systems are based on merely processing a business transaction. In MIS, the requirement is much higher as different areas of an organization like accounts, inventory, sales, purchase, marketing etc. needs to be tightly integrated to provide collective information to the management. MIS provides reports or feedback to the management with appropriate data, which arises from transaction processing systems. For example, MIS may be used by finance controller of huge organization to view daily budgetary positions in the budget heads. A sales manger may seek the report from MIS to judge the performance and work of their sales representatives. MIS also helps getting scheduled report of income, weekly report of sales etc.

1.4.4 Workflow System

Workflow systems in an organization are used to manage and control the interrelated activities required to perform a business goal. These systems help users, employees and managers to evaluate and control the status of different interrelated tasks. These systems are based on certain rules that control the flow of the tasks. Primary objective of workflow systems is to provide tracking and routing of tasks or documents from one process to another. **For example,** in any typical university, a student falling short of attendance is required to take permission before appearing in the examination. Suppose the rules state that if a students attendance falls short up to ten percent then permission from head is required; if the attendance falls short up to twenty percent then permission from principal is required; if the attendance falls short of twenty-five percent or more then permission of dean is required. If all officers of university and students are connected via network, a student may download the application form and submit it electronically. The various steps i.e. routing of application from one desk to another will be monitored and permission from the concerned persons will be transmitted to student for the examination cell. There exist few workflow system tools out of which Lotus Notes, MS Exchange and Novell Group Ware are popular. Major advantages of workflow system include reducing time due to retyping, filling the option form and reports, and amount of work towards the reconciliation of several reports.

1.4.5 Decision Support System

As we have discussed that MIS is helpful in meeting the organization's requirement to automate the business process and produces required information to employee or manager. MIS helps the organization to do the different task correctly but lacks in decision-making capabilities. Decision Support System supports management solving business problems. It often may not be solved by management information system. **For example,** many time management needs to decide which product of company should be continued and which product be discontinued. Deciding the areas, location and condition where a particular product have better sales prospects. These decisions are based upon certain underlying fact and feedback obtained by a company and its representatives. Taking these decisions MIS which merely provides processing data and also provides the information, are not sufficient. It requires to prepare the information specific formats and certain organization specific methdos needs to be deployed to take appropriate decision. After introduction of MIS at a later stage, organization has started feeling that MIS are not able to meet the decision making requirement of the management, as management had to

remain dependent on the MIS for getting appropriate information for decision making. **A Decision Support System** is a collection of software and hardware to support decision-making in specific environment or problem. The main objective of decision support system is to suggest the right options. Most of the cases, to solve complex problem where information to make effective decisions are difficult to obtain, the Decision Support System are used. Decision Support System are often designed as per the manager's requirement and plays a vital role in making managerial judgements. Decision Support System are designed around the business policies and methods for decision making and supporting database to provide information.

1.4.6 Expert Systems

Expert Systems are used to solve the problems of individual by providing expert decision making. These systems use Artificial Intelligence to solve the problem that requires significant human expertise. To the core, Expert Systems are computer based systems that emulate the decision making capability of human expert. Emulation means that computer system acts as an expert. The general purpose MIS are used to gather information from the database and decision support system helps us in decision making process, the expert system goes beyond the scope of MIS and DSS, Expert System provides the expert guidance to make use of a specialized knowledge required for decision making. These systems incorporate the knowledge which are not available to most of the people. The work Expert System and knowledge based system are often used interchangeably. One of the classical expert systems MYCIN was developed to provide the expert guidance to individual for medical diagnosis. In contrast to the expert system, several knowledge based system has also been developed for providing knowledge as an intelligent agent to human expert. Most of the expert systems are designed around knowledge base and inference engine. The user enters the information and expert system provides the response by invoking inference engine which draws the conclusion from the basis of information stored in knowledge base. One of the limitations posed by the expert system is that the knowledge and the techniques used by inference engines limit its performance. If the knowledge base does not have knowledge or information about any one of the facets, it may not provide the expert guidance.

1.5 IMPORTANT DATA TYPES

The most popular way of representing information is in the textual form. In this form, a combination of letters, numerals and some special characters are used. However, today there are several other ways in which data can be represented. These are Text, Image, Graphics and Animation, Audio and Video forms.

1.5.1 Text

Text is a collection of alphabets (both lower and upper case), numerals (0–9) and special characters (* , ? , : , #) etc. Data presented in textual form may be written and read. The information content in the text can be determined only after reading and interpreting it. Any collection of these characters does not constitute information; it is necessary to organize the characters according to some order or plan, then only it can have informative value.

1.5.2 Image

Images are another form of data type. Images refer to data in the form of pictures, photographs, hand drawings etc. Suppose we have to create a database for the employees of an organization to develop identity cards with photographs of the employees. To generate the identity card, it is required to store several attributes of employees. These are Employee Id, Employee name, Date of Birth, Address, Telephone Number etc. All this information may be stored in a textual form and may be printed on the