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# **Detailed Curriculum**

**Introduction to Information Systems:** Managing the Digital Firm – Information Systems in the Enterprise – Organizations – Management and Strategy – Electronic Commerce – Electronic Business – Analyzing Business Processes for an Enterprise.

**Management and Systems:** Role of Management Information Systems – Organizational Theory and the Systems Approach – Role of a Manager – Database Management – Information Systems for Decision-Making.

**Planning, Implementation, Evaluation and Maintenance of MIS:** Strategic and Project Planning for MIS – Strategic Information Systems Plan – Implementation and Evaluation of MIS – Maintenance of MIS – Advantages and Disadvantages of MIS.

**Management Control Systems and Managerial Controls:** Introduction to Management Control Systems – Designing the Control Process and Managerial Controls – Budget as an Instrument of Control – Variance Analysis for Control Actions – Key Variables and Performance Measures.

**Decision Support Systems: An Overview:** Decision-Making Process – Types of Decisions – Introduction to Decision Support Systems – Group Decision Support Systems – Basic Components of Decision Support Systems – Facilitating Problem-solving and Aid for Non-Structured Problems.

**Decision Support System Architecture:** Basic Architecture of Decision Support System – User System Interface – Language System – Presentation System – Knowledge System – Knowledge Management Systems (KMS) – Problem Processing System.

**Building Decision Support Systems:** Phases of DSS Development Process – System Development Life Cycle – ROMC Analysis – Prototyping – Functional Category Analysis – Incremental Design – Skill Set of DSS Developer.

**DSS Development Tools:** Tools for DSS Development – Intrinsic and Extrinsic Tools – Interface Styles – Multi-technique Integration of Tools.

# <u>Chapter I</u> Introduction to Information Systems

# After reading this chapter, you will be conversant with:

- Managing the Digital Firm
- Information Systems in the Enterprise
- Organizations
- Management and Strategy
- Electronic Commerce
- Electronic Business
- Analyzing Business Processes for an Enterprise

The innovations in the field of technology in general and the applications of Information Technology (IT) in particular are taking place rapidly around the world. For example the use of high-speed Internet connections for sending and receiving e-mails, telephones connected to the Internet, and mixed-mode handheld devices that combine phone, Internet and the computational capabilities to the growing number of mobile users, employees and students etc. A new business culture that is heavily dependent on the Internet is emerging which would have a deep impact on the way business is conducted. Communication between vendors, customers and employees at all possible times (whether day or night) is possible with Internet, which has made the world a global village. IT refers to the technology through which information is delivered by means of computers systems in organizations. The digital revolution that has been possible on account of IT has reduced the time and cost of production of goods and services in firms, industries and markets.

# **1. MANAGING THE DIGITAL FIRM**

Organizations today have to constantly reduce costs, introduce new and innovative products, and satisfy increasing customer demands. Customers are demanding lower prices, more product options and customization, improved level of services, and personalized treatment. To a great extent, the Internet has helped organizations cope with these demands. For instance, the physical transfer of business documents and face-to-face interaction of the sales force with the clients has declined significantly due to the Internet thus helping organizations reduce costs and offer personalized services. Organizations are increasingly using e-mails, chat, and other online tools as well as mobile devices like PDAs and mobile phones to conduct business.

Increasing use of electronic media, primarily the Internet, to conduct business and government transactions and the increasing popularity of the Internet among individual customers have ushered organizations to the digital era. Emerging ebusiness and mobile technologies, and the increasing availability of broadband telecommunications, have all catalyzed the entry of organizations into the digital era.

Organizations are leveraging the Internet not only to reduce costs but also to improve logistics, inventory, and Supply Chain Management (SCM) activities; plan production activities; and gain extended market reach. The Internet has enabled organizations to conduct business round the clock, compress business processes, and perform business activities quickly. The digital processing of orders for goods and services helps organizations save time, reduce cost, and enhance customer convenience. Companies lacking online business capabilities will find it hard to survive in the digital era.

# 1.1 Importance of Information Systems

Information systems play three vital roles in any type of organization. They support business operations, guide managerial decision-making, and provide strategic and competitive advantage to the organization. The hierarchical classification of an organization comprises three levels – operational, tactical, and strategic. The nature of decisions made at each level is different. Therefore, the information requirements at different levels are also different. At the operational level, a large quantity of data needs to be processed. This data is usually generated by business transactions with customers, suppliers, etc. At the tactical level, the concern shifts from day-to-day decisions that have a short-term focus, to those, which have a medium-term impact on the organization. Consolidated reports on the performance of various business units would be required to compare plans with actual performance, and to take remedial measures for any deviations. At the strategic level, in addition to the internal information, the decision-makers need information from the external environment as decisions at this level are taken in situations marked by uncertainty.

Depending on their use in a business, information systems can be classified as – Transaction Processing Systems (TPSs), Management Information Systems (MIS), Decision Support Systems (DSSs), and Executive Information Systems (EISs). Artificial Intelligence (AI) is also used by many organizations to improve precision in production/operation or decision-making.

IT has its greatest impact on the working style of managers and they in turn influence the whole organization. Following are the reasons where IT would make a difference to the profession of management graduates from business schools or in other words, the managerial personnel.

- i. Capital Management: The share of IT in the capital investment decisions of the firms, is the largest in the industrialized world, particularly the United States of America (USA). The expenditure incurred on IT, electronics and telecommunications devices and software would run into trillions of dollars. Therefore, management graduates, when they start their career, would commonly find the firms that have heavily invested in IT and using IT systems on a very large scale. By making appropriate investment in the technological upgradation of IT systems, a company would be in a much better position to perform better than its competitors and thus gain invaluable and dominant market share.
- IT Foundation of Business: The number of employees, both managerial and ii. worker category, who are making use of information systems in their every day life for the conduct of business and professional advancement in their career is increasing with each passing day. Firms cannot lag behind in starting E-commerce transactions and hence would have to invest substantially in the field of IT. In the 20th century, office infrastructure in the form of telephones, tall and magnificent buildings, filing cabinets and elevators were the foundations of business. Coming to the 21st century, IT has become the foundation of business. For a business organization, there is a close relationship between the implementation of corporate strategies and achievement of goals and the ability to use IT. It can also be argued within the next five or ten years, a firm would want to increase its market share, produce quality goods at the minimum cost, develop new products and increase its productivity and performance. These expectations or corporate goals depend heavily on the quality of information systems and resources present in the organization.
- iii. Productivity: In the face of intense competition from around the globe, managers face an uphill task of achieving remarkable profits and gains in productivity due to limited number of tools and techniques. IT is one of the significant tools along with unique ways of thinking and organizing. Research has pointed out that IT has a very important role to play in increasing the productivity of firms and in the growth of the economy. The growth of US economy benefited on account of IT. Those firms which have invested early in IT have experienced a continuous growth and increased efficiency.
- iv. Strategic Opportunities: Strategic thinking demands that one should take note of new opportunities in the market and develop new products and services. This requires a large investment in IT. Consequently, the returns will also be very high. IT plays an important role in order to differentiate the products and services offered by one company from that of the other. This will result in competitive strategic advantage. Even though competitive advantages are short-lived but IT helps in generating a large number of them.

# **1.2 The Internet-worked Enterprise**

The explosive growth of the Internet and related technologies and applications, has left a tremendous impact on business, society and information technology. The Internet has completely changed the way businesses operate and people work. It has also brought about a change in the way Information Technology supports business operations and other end-user work activities.

Present day businesses are becoming internet-worked enterprises with the Internet, intranets, extranets and other networks supporting the major business operations of many organizations. This is especially seen in the areas of electronic commerce systems among businesses and their customers and suppliers, and enterprise collaboration systems among business teams and work groups. An internet-worked enterprise uses the Internet, intranets, extranets and other networks to support every step of the commercial process. This may include everything from multimedia advertising, product information and customer support on the World Wide Web, to Internet security and payment mechanisms that ensure completion of delivery and payment processes. This is very evident in areas like electronic commerce. Electronic commerce involves buying, selling, marketing and servicing of products, services, and information with the help of a variety of computer networks. E-commerce may include use of multimedia web pages consisting product catalogs on the Internet, access of inventory databases by large customers through extranets, and the use of a corporate intranet by sales representatives to access customer records.

# **1.2.1 GLOBALIZATION AND INFORMATION TECHNOLOGY**

Many companies today are in the process of becoming internet-worked global enterprises. Businesses are venturing into global markets for their products and services, using global production facilities to manufacture or assemble products, raising money in global capital markets and forming alliances with global partners. Moreover, they are also competing with global competitors from all over the globe. Implementing these strategic changes would be nearly impossible without the Internet, intranets, and other telecommunication networks, which form the central nervous system of today's global companies.

Global companies operate in a competitive environment in which internet-worked computer systems make possible the creation of a virtual global market that can instantly and cost effectively process business transactions. Moreover, companies can now form global business alliances with other organizations, customers, suppliers, former competitors, consultants, and government agencies. Internet has also made it possible to pool human resources from all over the world and tap the variety of skills they possess. This has, in turn, led to an improvement both in the quality and productivity of goods and services.

# 1.3 Resources Needed by an Information System

An Information System (IS) is one that accepts data resources as input, processes them and provides output in the form of information products. An information system consists of people resources (end-users and IS specialists), hardware resources (machines and media), software (programs and procedures), data (data and knowledge bases), and networks (communications media and network support) which perform input, processing, output, storage, and control activities and convert data resources into information products.

The five basic resources of information systems are: people, hardware, software, data, and networks. They are explained below:

i. **People Resources:** People are indispensable for the operation of information systems. People resources include end-users and specialists. *End-users* are people who use information products for their varying needs. They can be accountants, salespersons, engineers, clerks, customers, or managers.

Introduction to Information Systems

*Information System (IS) specialists* are people who develop and operate information systems. They can be systems analysts, programmers, computer operators, and other managerial, technical and clerical IS personnel. While system analysts design information systems based on the information requirements of end-users, programmers prepare computer programs based on the specification of systems analysts, and computer operators facilitate operation of large computer systems.

- ii. **Hardware Resources:** Hardware resources include all physical devices and materials used in information processing. It includes machines such as computers and data media. All tangible objects on which data is recorded comprise the hardware resources. The hardware in computer-based information systems are: Computer systems and Computer peripherals.
- iii. Software Resources: Software resources include all sets of information processing instructions. They not only include the sets of operating instructions called programs that direct and control computer hardware, but also the sets of information processing instructions needed by people, called procedures. Software resources are required in the form of information processing instructions and procedures to properly capture, process, and disseminate information to their users. Some of the software resources are:

System software is an operating system program, which controls and supports the operations of a computer system. Application software consists programs that direct processing for particular use of computers by end-users such as a sales analysis program, a pay-roll program, etc. Procedures are operating instructions for the people who will use an information system such as instructions for filling out a paper form or using a software package.

- iv. **Data Resources:** Data constitutes a valuable organizational resource. It should be viewed as a resource that must be managed effectively to benefit all end-users in an organization. It can take many forms, including traditional alphanumeric data consisting numbers, alphabets and other characters that describe business transactions and other events and entities. Other important forms of data are text data consisting sentences and paragraphs used in written communication, image data such as graphic shapes and figures, and audio-data such as human voice and other sounds. The data resources of information systems are: Databases that hold processed and organized data and knowledge bases that hold knowledge in a variety of forms such as facts, rules and cases about successful business practices.
- v. Network Resources: Telecommunication networks like the Internet, intranets and extranets have become essential for the successful operation of all types of organizations, and their computer-based information systems. These networks consist computers, communication processors and other devices interconnected by communication media and controlled by communication software. Network resources include:
  - Communication media comprising twisted-pair wire, coaxial cable, fiberoptic cable, microwave systems, and satellite communications systems.
  - Network support comprises all people, software, hardware and data resources that directly support the operation and use of a communication network. Some examples are communication processors such as modems and internet-work processors, and communications control software such as network operating systems and Internet browser packages.

# 1.4 Role of Internet in the IT Infrastructure

Internet is an international network connecting large number of computer networks around the world. In today's world, it has become the largest, ever expanding and most important network of networks. It is evolving into the information superhighway for years to come. Its expansion is mainly due to ever increasing

number of businesses, users, computers, educational and scientific institutions and networks who are joining its global web. All the countries in the world have Internet users. Internet has become an important platform for a rapidly expanding list of information and entertainment services and business applications, including enterprise collaboration and electronic commerce systems. The growth of Internet can be gauged from the fact that its size is doubling every year.

Internet was conceived by the Advanced Research Projects Agency (ARPA) of the US government in 1969 and was first known as the ARPANET. The original aim was to create a network that would allow users of a research computer at one university to be able to access information from research computers at other universities. The advantage offered by ARPANET's design was that, because messages could be routed or rerouted in more than one direction, the network could continue to function even if parts of it were destroyed in the event of a military attack or any other disaster. Today, Internet is accessible to millions of users, worldwide because it is a public, cooperative, and self-sustaining facility. For its physical existence, the Internet uses a small part of the total resources of the currently existing public telecommunication networks. In technical terms, Internet uses a set of protocols called TCP/IP (Transmission Control Protocol/Internet Protocol). Two new developments in the field of Internet technology, the intranet and the extranet, also make use of the TCP/IP protocol.

The most widely used application of Internet is the electronic mail popularly known as E-mail. Messages can be sent and received between E-mail account holders with the help of E-mail facility. This facility has replaced the postal services to a very large extent. The most widely used part of the Internet is the World Wide Web (often abbreviated "WWW" or called "the Web"). Its outstanding feature is hypertext, a method of instant cross-referencing.

# **1.4.1 APPLICATIONS OF INTERNET**

The following are the applications of Internet:

i. **World Wide Web:** The World Wide Web, or simply Web, is a way or a medium for accessing, or publishing information and running business applications on the Internet in an easy to use form on the Internet. WWW uses HTTP protocol. It is like a language used to transmit data on the web. The WWW medium is based on standard document which is formatted in a language called HTML (HyperText Markup Language). HTML is basically a method used to create web pages and documents.

One of the outstanding features of WWW is hypertext which allows to jump from one web page to another instantly by clicking certain underlined words or phrases appearing on the web page in text.

It supports links to other documents, as well as graphics, audio, and video files. This means it is possible to jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the World Wide Web. Internet browser software like Netscape Navigator and Microsoft Explorer enable millions of users to surf the WWW for thousands of hyperlinked websites and resources for multimedia information, entertainment, or electronic commerce. It is also widely used for publishing information.

ii. **E-mail:** It is the short form for Electronic mail. It refers to the transmission of messages over communications network. The messages can be entered from the keyboard or they may be in the electronic files stored on disk. Internet messages arrive faster than many public networks. Messages can be sent or received in seconds or in a few minutes anywhere in the world. They may take the form of data, text, fax, and video files. Internet browser software like Netscape Navigator and Microsoft Explorer enables millions of users to surf the WWW by moving through the multimedia information resources stored on the hyperlinked pages of businesses, government, and other websites.

A fully computerized environment in a company is very helpful to make extensive use of e-mail because it is fast, flexible and reliable. Most e-mail systems provide the facility of a rudimentary text editor for composing messages. The message is sent to one or more recipients by specifying the address of recipients.

- iii. Usenet: It is a worldwide bulletin board system that can be accessed through the Internet or through other online services. Electronic bulletin board is an electronic message center. Most bulletin boards serve specific interest groups. Interested users can dial in with a modem, review messages left by others, and leave their own message. Some Bulletin boards are good places to find inexpensive software. The USENET contains more than 14,000 forums, called *newsgroups* covering varying interest groups. It allows participation in discussion forums or posting of messages on bulletin board systems. Millions of people around the world use it daily.
- iv. **Internet Relay Chat:** It provides the facility for Internet users from any part of the world to enter in live discussions. There can be many discussions going on simultaneously. It provides the facility of holding real-time text conversations with other Internet users around the world on hundreds of discussion channels.
- v. File Transfer Protocol (FTP): It helps the Internet user to download data files, programs, reports, articles, magazines, books, pictures, sounds and other types of files from thousands of sources to his/her computer system. This protocol is very common to download a file from a server using the Internet or to upload a file to a server. (Example, uploading a Web page file to a server.)
- vi. **Telnet:** It is a terminal emulation program for TCP/IP networks such as the Internet. A terminal emulation program allows access to a mainframe computer or a bulletin board system with a PC. The Telnet program runs on the computer system of the user and provides connection between the user's PC and the server on the network. This allows the user to enter commands through Telnet program and these commands will be executed as if they were entered directly on the server console. The user can control the server and communicate with other servers on the network. To start a Telnet session, a user has to log in to a server by entering a valid username and password. Thus, the user can use thousands of Internet computer systems around the world.
- vii. **Other uses:** Long distance phone calls have become very cheap with the help of Internet. Internet also allows holding desktop videoconferences, listening to radio programs, watching television, exploring virtual worlds etc.

# **1.4.2 BUSINESS APPLICATIONS OF INTERNET**

The following are the business applications of Internet:

- Internet provides a convenient means of gathering information from different web pages in a very short time. It helps business organizations to keep themselves abreast with the latest happenings in the industry with regard to new products, innovations, new methodologies, processes and techniques, conferences etc.
- ii. It provides a better way to collaborate with business partners and industry associates. It helps to develop a better understanding with the government agencies by getting latest information on the legislative and regulatory measures of the government. Companies can bid for government contracts with the help of websites in a hassle-free manner.

Internet and websites can be used for customer service and support, to disseminate published information, purchase and sale of products and services with the help of websites, advertisement of products and services, and to know public opinion about the company and its products.

- iii. Internet can be used to establish business relations with suppliers and customers. The electronic business contracts with the suppliers ensure that the stocks are replenished in the inventory at the appropriate time without the need for lengthy administrative process which causes undue delay. This is made possible with the help of private virtual networks. Similarly, goods can be supplied to customers through online collaboration.
- iv. Companies can provide information about themselves and their financial performance through E-mail and their websites to prospective and current investors. This is a cost-effective method of reaching a large number of investors and the name of the company will spread far and wide. In addition, the company can track the activities of stock and bond markets and tap cheapest sources of finance from around the world.
- v. The research and development department of the company can obtain valuable information from the Internet because it is a well established repository of information on any topic of interest. Scientific collaboration between industry, research institutions and the universities across the globe can greatly enhance the development of cutting edge technologies for products and services. Researchers in the R&D department can file patents with the government through websites.

#### **1.4.3 INTRANET**

An intranet is a private network that exists within an enterprise and it is basically a private version of Internet. It is designed to meet the internal information needs of the employees. Unlike Internet, it is not a public facility because its access is restricted only to authorized employees, contractors and customers. It uses TCP/IP, HTTP (Hypertext Transfer Protocol) and other Internet protocols. The main purpose of an intranet is to share non-sensitive company information and computing resources among employees. An intranet can also be used to facilitate working of groups and for teleconferences. The information that is communicated over intranet may relate to:

- Recent corporate news,
- General product information,
- Details of health insurance,
- Travel expense forms,
- Prices of the products, and
- In house training programs.

Companies can also send private/confidential information through public network with special encryption/decryption techniques or other safeguards to connect one part of the intranet with the other. In addition, companies allow the users of intranet to access information from public networks through firewall servers that have the ability to screen messages in both directions so that the security of the company is not breached.

#### **Advantages of Intranet**

The following are the advantages of intranet:

- i. Intranet has become an easy, fast and economic means of communication within enterprises.
- ii. Since it is based on Internet protocol, it is possible to expand its accessibility. It can automatically serve information needs.
- iii. Employees can obtain official communication from the management on important matters with ease.
- iv. The productivity of the company executives is increased dramatically because information will be at their fingertips and hence they will have more time to analyze such information.

- v. It is easy for the management to provide information to their employees who are working in different branches across the globe.
- vi. Intranet can also handle multimedia data effortlessly.

#### **Disadvantages of Intranet**

The following are the disadvantages of intranet:

- i. Due to rapidly changing technologies, the corporate information resources may face the risk of breach of security from sophisticated hackers.
- ii. The implementation of intranet will be successful only when employees are properly trained to use it with well defined documentation of processes and methods. Employees' acceptance and desired changes in the work culture are also essential.
- iii. With intranet, there is only electronic or online communication between the employees and the management or between different employees of a work group. Thus, it greatly reduces face to face communication. This may lead to impersonation of the company.

#### **1.4.4 EXTRANET**

An extranet is a private network that uses Internet technology and the public telecommunication system to share part of a business's information or operations with suppliers, vendors, partners, customers, or other businesses in a secured environment. Unlike intranet, extranet is directed at customers or suppliers instead of employees. It can be viewed as a part of company's intranet which is extended to users outside the company. Extranet provides information which satisfies the needs of customers regarding detailed product description, frequently asked questions about different products, office maintenance information, warranties and customer service/sales. An extranet can cater to the needs of large number of customers or suppliers by making use of a single interactive site. Thus, there is no need for the company to contact individual customer or supplier. This greatly reduces the paperwork of the company. Since information resources are shared through extranet, they requires security and privacy features. These include firewall server management, the issuance and use of digital certificates, authentication and encryption of messages and the use of Virtual Private Networks (VPNs).

#### **Advantages of Extranet**

Companies can use extranet to:

- Exchange large volumes of data using Electronic Data Interchange (EDI).
- Share product catalogs exclusively with wholesalers or business partners.
- Collaborate with other companies to impart training programs.
- Collaborate with other companies to jointly develop product and services or undertake collaborative research work.
- Provide or access services provided by one company to a group of other companies, such as an online banking application managed by one company on behalf of affiliated banks.
- Share news of common interest exclusively with companies who are business partners.

# 2. INFORMATION SYSTEMS IN THE ENTERPRISE

We have studied earlier that an information system is a system, whether automated or manual, that comprises people, machines, and/or methods organized to collect, process, and distribute data and information in an organization. It usually includes hardware, software, people, communications systems such as telephone lines, and the data itself. In this section, we shall describe the major information systems that lend support to the prominent business functions and provide examples of functional applications.

#### 2.1 Marketing Information Systems

It is a system which is designed to meet the information needs of an organization in sales, distribution, advertising, market analysis, market intelligence, product research, service management, customer profile, and other marketing functions.

Organizations are established to carry out certain functions in the society. For instance, the business of banking organization is to carry out monetary functions. Any organization has to orient itself towards the goal of satisfying customers. In this case, marketing of goods and services play an important role in establishing the bond between the customers and the company. It is the marketing department which is a link between the company and its customers. Based on the inputs obtained from the marketing department, the production department designs the products and the finance department allocates resources in the development of particular products. Thus, the information systems designed for carrying out marketing functions need to be customer-oriented such that strategic sales plan and the marketing plan of an organization can be realized. Thus, each organization needs to have a marketing information system which is dedicated exclusively to the marketing function of the organization.

The earliest marketing systems were designed to process the transactions relating to sales invoices and sales accounting. The automation of sales and marketing functions were very popular under this system. These systems collect customer information which include customer tastes and preferences, customer price band, needs of customers, and also discover multiple utilities of the product. This information is useful to enhance productivity, customer service and decision-making capability regarding price fixation, sales and marketing strategies. The company can benefit from the information collected regarding the effectiveness of advertisement strategy, merchandising opportunities, stock on hand, and demand for the products, etc. One of the most common methods to collect data from different geographical locations is that the sales persons are allotted PCs or laptops to enter data collected in their respective locations. The PCs and the laptops are connected to the main server of the company. At the company's headquarters, the data thus collected is analyzed and necessary decisions are taken. These decisions are communicated through telecommunication devices.

## 2.1.1 DEVELOPING MARKETING INFORMATION SYSTEMS

Marketing information systems requires the creation of a database that has marketing data collected from internal and external sources. This data relates to the loyal customers and also those customers who either prefer a different brand or do not use the product. With the help of this database, the company can devise strategies to strengthen the loyalty of existing customers, attract such customers who prefer other brands with new promotional schemes and also educate those customers who are not using the product. In addition, the information system should collect data relating to the suppliers and corporate customers, who make sales or purchases in bulk quantities. For such corporate customers and suppliers, the company can install automated systems to collect or place orders which are not only frequent but also for bulk quantities. The company has to take into account the willingness of the clients to adopt the new technology before its introduction.

The different facets of marketing information system are as follows:

- Interactive Marketing: In interactive marketing, a two-way communication is established between the company and its customers (or potential customers) with the help of Internet, Intranet and Extranet. Through interactive marketing, the company could strengthen the communication channels with its customers, who are interested in establishing relationship with the company, by designing, purchasing and improving products and services.
- Sales Force Automation: Sales force is very important for the company because it ultimately sells the products and services of the company and the survival of the company, its profitability and ultimately its reputation is

determined only through the proper sale of its goods and services. In today's competitive business environment, Information technology has provided notebook computers, Web browsers and sales contact management software to automate sales force and connect them to marketing websites on the Internet, extranets and their company intranets. This not only increases personal productivity of the sales force but also results in increased market share for the company. With the help of automated sales force, the marketing department can gain insight into the areas of advertising effectiveness, needs of the customers, supply chain management and strategic objectives.

- Sales and Product Management: In order to enhance the productivity of the sales personnel, it is not enough for the company to provide them with modern IT devices and facilities. The company has to monitor their performance in the field and reward them so as to maintain high levels of motivation. Sales managers must plan, monitor, train and support the performance of the sales personnel at the field level. The data related to the sale of different products in different territories and to different types of customers need to be properly analyzed to improve the sales results. Computer-based models help managers to evaluate the performances of current products and the prospects for success of proposed products.
- Advertising and Promotion: Advertising and promotion play an important part in the successful sales deal of products and services with customers. Marketing information systems use the data obtained through market research and promotional models to (i) Select media and promotional methods, (ii) Allocate financial resources, and (iii) Control and evaluate results of various advertising and promotional campaigns.
- **Targeted Marketing:** Targeted marketing is an advertising and promotion management concept that includes five components that are to be targeted. They are:
  - i. **Community:** Particular products of a company satisfy the needs of particular community. Thus, web advertising and promotion methods can be designed to attract people from such communities.
  - ii. **Content:** Electronic billboards or banners can be placed on various website pages in addition to company's home page to attract the attention of potential customers.
  - iii. **Context:** Advertising should appear only on web pages that are relevant to the content of a product or service. This is to attract the attention of the people who are looking for the information of their choice.
  - iv. **Demographic/Psychographic:** The target group of customers of the company may be unmarried individuals, middle income people, people above the age of sixty years, college going males etc.
  - v. **Online Behavior:** Cookie files enable a company to track a person's online behavior at a Website so that marketing efforts can be instantly developed and targeted towards that individual whenever he visits the website.
- Market Research and Forecasting: Market research information systems provide marketing intelligence to help managers make better marketing forecasts and develop more effective marketing strategies. With the help of marketing information systems, market researchers collect, analyze and maintain an enormous amount of information on a wide variety of market variables that are subject to continuous changes.

#### 2.1.2 ADVANTAGES OF MARKETING INFORMATION SYSTEMS

Following are the advantages of marketing information systems:

- i. Marketing Information Systems helps the companies to increase their market share, discover and develop new products and markets, achieve customer satisfaction, develop strategic interests and partnerships with other firms and enhance the quality of their products.
- ii. Marketing Information Systems provides the decision makers with timely and relevant data about customers in different geographical locations which enhances the decision-making capability. With the help of this data, the company can design products or make variations in the existing products based on the needs of customers. For instance, car manufacturers design the cars based on the driving habits of the customers (for example, the car drivers in India are accustomed to right hand drive whereas the western car drivers are accustomed to left hand drive) and the condition of roads in different countries.
- iii. Marketing Information Systems is greatly useful in the present day businesses phenomenon where retail stores and Fast Moving Consumer Goods (FMCG) dominate the urban areas. Consumer preferences for particular goods, the price they are ready to pay, their opinion on after sales service, etc., are the input variables which are captured by the marketing information system.
- iv. Marketing Information Systems has important bearing on the quality of the customer service. Inadequate, incomplete or poor customer service is regarded as the result of poor quality of information systems.

# 2.2 Manufacturing Information Systems

A manufacturing information system is defined as a system that supports the manufacturing functions of purchasing, receiving, quality control, inventory management, material requirements planning, capacity planning, production scheduling, and plant design. The term manufacturing should be used not only in the case of delivery of goods but also of services. For instance, a manufacturer of cement and a travel agency are both likely to have manufacturing information systems. A subset of manufacturing systems is the production system which is concerned directly with the production of goods and services. It relates to acquiring and managing raw materials, scheduling equipment, manpower planning, repair and maintenance, and other activities related to production.

#### 2.2.1 COMPUTER INTEGRATED MANUFACTURING (CIM)

It is a phrase used to describe the complete automation of a manufacturing plant, with all processes functioning under computer control and digital information tying them together. Under Computer Integrated Manufacturing (CIM), Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM), Computer-Aided Process Planning (CAPP), computer numerical control machine tools, Direct Numerical Control Machine Tools (DNC), Flexible Machining Systems (FMS), Automated Storage and Retrieval Systems (ASRS), Automated Guided Vehicles (AGV) and robotics are included. The goal of CIM is to develop flexible, agile, manufacturing processes so that they can produce high quality products. CIM supports of flexible manufacturing systems, agile manufacturing, and total quality management.

The objectives of CIM in computer-based manufacturing environment are as follows:

- Simplification of production processes, product designs, and factory organization, which will serve as a foundation for automation and integration.
- Automation of production processes and the business functions with the help of computers, machines and robots.
- Integration of all production and support processes with the help of computers, telecommunications networks and other information technologies.

# 2.2.2 COMPUTER AIDED MANUFACTURING (CAM)

These systems automate the production process. Automation is carried out by monitoring and controlling the production process in a factory through Manufacturing Execution Systems (MES) or by directly controlling a physical process (process control), a machine tool or by means of robots.

#### 2.2.3 MANUFACTURING EXECUTION SYSTEMS

These systems monitor the performance of the operations carried out at the factory floor or shop floor. They monitor, track, and control the five essential components involved in a production process: materials, equipment, personnel, instructions and specifications, and production facilities. It includes shop floor scheduling and control, machine control, robotics control, and process control systems. These manufacturing systems monitor report and adjust the status and performance of production components so that the company can benefit from a flexible and high quality manufacturing process.

# 2.2.4 COLLABORATIVE MANUFACTURING NETWORKS

Computer-aided engineering and design, production control, production scheduling and procurement management which come under the purview of manufacturing processes, involve a collaborative process among the employees. The engineers and experts at the workstation can maintain links and contacts with their colleagues at different sites with the help of Internet, intranets, extranets and other networks. The networks involved in collaborative manufacturing systems may also link employees within a company or establish link with the suppliers and customers of the company at distant locations.

#### 2.2.5 PROCESS CONTROL

There are a number of physical processes being carried out in a manufacturing unit that need accurate control and feedback mechanism at a minute level. The control and feedback at this level can be provided by computers in the fields like petroleum refineries, cement plants, steel mills, chemical plants, food products manufacturing plants, pulp and paper mills, electric power plants etc. The computer systems are linked to sensors which can measure the changes in physical environment like temperature or pressure. These physical quantities are converted into digital form with the help of Analog-to-digital converters. The computer can process the input given to it in digital form. The process control software uses mathematical models to analyze the data given to it and compares its output with the standard output to find out any discrepancies in the output. Based on the discrepancies shown by the computer system, corrective measures are taken. Thus, the physical process can be improved in a very short time due to the high processing speed of the computers.

#### 2.2.6 MACHINE CONTROL

It involves the use of computer to control the processes of a machine. It is widely known as numerical control. Initially, engineers develop the blue print on the design of the machine and its working capacity. Computer programs for machine tools convert geometric data from engineering drawings and machine instructions into numerical code of commands that control the processes of a machine. There are special purpose microcomputers called Programmable Logic Controllers (PLCs) which are responsible for machine control. Based on the instructions given in the numerical control program, the PLCs operate one or more machines.

#### 2.2.7 ROBOTICS

It is the technology of building and using machines (robots) with computer intelligence and computer-controlled human-like physical capabilities (dexterity, movement, vision, etc.). It is a highly automated system that requires minimum or no human intervention. In the field of artificial intelligence, the field of robotics is receiving a lot of attention. In the manufacturing and industrial world, robots are being widely used in those areas where the work is hazards prone or where it is

impossible for human being to work under extreme environmental conditions. Robots are fitted with microcomputers and visual/tactical sensors. They have movable arms and legs which help them to perform such tasks like painting, drilling or welding.

#### 2.2.8 COMPUTER-AIDED ENGINEERING

The models of product design are developed using Computer-Aided Design (CAD) methods. The models of these products are analyzed and evaluated with simulation techniques with the help of Computer-Aided Engineering (CAE). Networks of powerful engineering workstations with enhanced graphics and computational capabilities and CAD software help them analyze and design products, manufacturing processes and facilities. CAD packages convert the drawings of the product conceived by the engineer into three dimensional computer graphics. The three dimensional computer graphics of the product helps the designer/engineer to examine in detail, every part of the product on the computer screen. Then the graphical design is converted into a finished mathematical model of the product. This mathematical model is used as the basis for production specifications and machine tool programs.

# 2.2.9 MATERIALS REQUIREMENT PLANNING

The first requirement in the process of manufacturing is the raw materials. Thus the plan to acquire raw materials, their rate of usage and degree of importance are all covered under Materials Requirement Planning (MRP). Materials Requirement Planning is defined as a process for determining the amount of raw materials, labor and machine requirement necessary to manufacture a specified number of products. The concept of MRP is increasingly becoming popular because computers are being widely used in planning and control process. MRP is useful in those situations where the end product requires a number of components or sub-assemblies. This concept provides a unique way of looking at the management of production inventories. Due to the constraints of financial resources, space and logistics, a company has to achieve optimum level of inventory to enhance profits.

MRP systems help users to manage a number of processes that make up a supply chain which includes determining the amount of inventory, forecasting and shipping of end products. First, the companies forecast the demand for their product which leads to the creation of a Master Production Schedule (MPS). To satisfy the demand for goods, companies have to develop material requirement plan. In addition, the companies have to access their capacity of production by preparing a Capacity Requirement Plan (CRP). CRP unveils the constraints that may be inherent in the production processes.

The introduction of computers has simplified the planning of inventory to a large extent. The software used for MRP computes the number of parts required to manufacture the end product and for the preparation of production and procurement schedules.

# 2.2.10 ADVANTAGES OF MANUFACTURING INFORMATION SYSTEMS

The following are the advantages of manufacturing information systems:

i. For any business undertaking, the manufacturing of goods and services is the most important task. The business organization derives its name, fame and reputation only on the basis of the quality of the goods and services it offers to the customers. The information generated at the shop floor about the goods and services like their quality, quantity, durability, manufacturing costs, etc., help all other departments and the top management to design their policies into successfully running the organization. Thus, the companies, which have well-integrated manufacturing information systems are bound to benefit to a greater extent than their competitors.

- ii. Manufacturing information systems are helpful to companies in simplifying, automating and integrating a number of activities that are needed to produce products of different types. Computers are being widely used in the design of the products and for proper utilization of raw materials from the inventory.
- iii. Improvements in the quality of manufacturing information systems has helped many business organizations all over the world in reducing operating costs, inventory levels and the number of employees. Business organizations are able to improve the quality of goods and services and sell their products at competitive prices and thereby helps them to increase the customer base.
- iv. Manufacturing Information systems can increase the productivity of machines and the human work force, quality and quantity of raw materials, helps to judge the relative importance of various items of inventory and reduce inventory costs, etc. This information system helps the company in designing various programs and policies for its future course of action.

# 2.3 Accounting Information Systems

It is the oldest and most widely used information systems in business. An organization carries out a number of financial and business transactions in its day to day operations with rest of the world. This information system records and reports such transactions and other economic events. It is based on double-entry book-keeping concept and other accounting concepts like responsibility accounting and activity-based costing. This information system is computer-based and it records and reports the movement of funds on a historical basis. It also produces the Balance sheet and Profit and loss account statements. With the help of these systems, accounting department can also produce forecasted financial statements and budgets. For many organizations, producing and reporting of many of the accounting records and statements is a legal necessity. In addition, stakeholders in the business like the suppliers, shareholders, employees, etc., are also influenced by the accounting records of the company.

# 2.3.1 IMPORTANT ACCOUNTING INFORMATION SYSTEMS

The important accounting information systems which deal with the accounting matters related to the production cycle are:

- i. **Online Accounting Systems:** Internet, intranets, extranets and other networks are being used to monitor and track business activity. This is an online interactive activity which is based on new forms of transaction documents, procedures and controls. The systems which have been brought under online accounting systems are order processing, inventory control, accounts receivable and accounts payable. Companies are establishing communication links with their customers and business partners so that transactions can be carried out in an online real time basis.
- ii. Order Processing: This system receives customer orders for goods and services and processes them. It also keeps track of the order and gives its status report to the customers until the goods are physically delivered to the customers. The forms for filling orders are available online for the customers.
- iii. **Inventory Control:** This system can keep track of the inventory levels to find out the availability of the goods after receiving orders from the customers. Thus, if the goods are not available in the inventory or the level of goods in the inventory has reached below the desired level then this system notifies the managers for appropriate action. These systems help in reducing inventory costs and also streamline the inventory management process.
- iv. Accounts Receivable: This system keeps records of the customers and the amount that they owe to the company after having purchased the goods on credit. They generate invoices to customers and credit management reports. This will help in comparing sales on cash and credit basis and implementing credit policy for different customers. Computer-based systems generate

timely and accurate reports and invoices which will help managers in taking decisions to improve the liquidity position of the company by eliminating/ reducing bad debts and losses.

- v. Accounts Payable: This system keeps track of the goods and services the company has purchased from its suppliers on credit basis. Computer-based systems help the managers to take decisions on the matters of quantity and cash discounts the suppliers offer. They can also maintain control over expenses and cash disbursements of the business.
- vi. **Payroll:** This system collects data related to the wages and salaries paid, taxes paid, employee benefits, wages paid for over time work, deductions, etc. It generates earning statements, payroll reports and labor analysis reports. Some reports are prepared for government agencies. Computer-based payroll systems help in generating timely and accurate reports which will in turn help in facilitating salary and other payments to the employees. These reports help the management in providing information regarding earnings, taxes, and other deductions.
- vii. **Computerized General Ledger System:** General ledger systems generate the company's income statements and balance sheets. This system generates new accounts and manages old accounts. This system can be implemented on a computer by integrating other sub-systems for the purpose of improving administrative efficiency. The important features of a computerized general ledger system are as follows:
  - Automatic double entry accounting.
  - Accruals and prepayments are automatically reversed in the next accounting period.
  - The general ledger is maintained as a database.
  - The linking of general ledger with purchase ledger results in standard monthly postings automatically.
  - A history file of all the transaction records can be maintained so that analysis and schedules can be produced at the year end.
  - This system produces Balance Sheet, Profit and Loss account and operating statement.
  - The variances between the actual and the standard budget can be determined for budgetary control.
  - Budgets can be altered by calculating the percentage changes so that financial projections can be known.
  - It is possible to reanalyze nominal accounts into cost or profit centers by producing reports in seven different types of sort keys.
  - A summary of each nominal account for each accounting period obtained by comparing to budgeted accounts of previous years can be used to produce year end report.
- viii. **Inventory Control System:** This system collects, processes and produces output from the data related to inventory items (raw materials, work-in-progress and finished goods). This includes levels of inventory, Economic Order Quantity (EOQ), re-order levels, accounting practices related to inventory, data on goods sold, purchased, returned due to defects, damaged or lost.

- ix. **Order Entry System:** The data related to transactions carried out like the number of units sold, customer billing, credit history, sales tax and inventory levels are collected and processed by this system. The output of this system serves as an input to other systems such as accounts receivable and inventory management.
- x. Asset Management Systems: This system maintains the record of long-term assets owned by the company and ensures that the accounting practices of the company in relation to the assets conform to the regulatory standards. The output of this system becomes input to the general ledger system.

# 2.4 Financial Information Systems

It is a system that collects data relating to the financial activities in an organization and processes this data to bring out that information which is useful for making decisions in the area of finance. It is integrated with other functional systems in the organization which helps in sharing of data, decision-making and allocation of financial resources. These systems help managers in taking decisions with respect to (i) sources of capital for a business, and (ii) allocation and control of financial resources within a business.

# 2.4.1 CATEGORIES OF FINANCIAL INFORMATION SYSTEMS

The major categories of financial information systems are:

- i. Cash Management: This system collects information on all cash receipts and disbursements within a company on a real-time or periodic basis. These systems ensure that the organization has adequate cash to meet its obligations. They generate daily, weekly or monthly forecasts of cash receipts or disbursements that can be used to forecast cash inflows or outflows. Thus it is the duty of this system to ensure that the company borrows and lends short-term cash on favorable terms, maintain proper liquidity to achieve good credit ratings and maintain adequate balance between cash receivables and payables. With the help of this system, managers can take investment decisions regarding the surplus cash and balance the liquidity position of the company. Mathematical models are frequently used to determine optimal cash collection programs and alternative financing or investment strategies based on cash deficits or surpluses.
- ii. **Online Investment Management:** Portfolio management software packages are available for selecting securities based on the risk and return preferences for investing excess cash of the company. Finance managers can achieve maximum returns with minimum risk by selecting optimum combination of securities. Securities can be bought and sold online with the help of Internet and other networks.
- iii. Capital Budgeting: This system ensures proper acquisition and disposal of long-term assets such as land, buildings, etc., so that the production of goods and services are not hampered. It also involves selecting the projects for investment based on their profitability. It involves analysis of long-term capital expenditure projects and the amount of capital to be invested in them using a variety of techniques. Spread sheet packages are used to determine cash flows and analysis of risk probability.
- iv. Financial Forecasting and Planning: Electronic spreadsheets and other financial planning software is available to evaluate the present and projected financial performance of a business. This system also helps in determining the financial needs of the business and the selection of alternative sources of finance like bonds, share capital, bank loans, fixed deposit from the public etc. It helps finance manager to determine the optimal combination of debt and equity to minimize the total cost of capital. Financial models can be built and manipulated with the help of electronic spreadsheet packages, DSS software, and Web-based groupware.

v. **Investment Management Systems:** Investment management systems ensure that the long-term needs of capital of the organization are met with favorable terms of interest rates. In addition, the firm invests in such projects which have the capacity to maximize the wealth of the shareholders.

# 2.4.2 FUNCTIONS OF FINANCIAL SYSTEMS

- The following are the functions of financial systems:
- i. Financial systems ensure that all business transactions are recorded in proper books of account on the basis of standard accounting practice. Such accounting records are meant to assure the owners of the business, i.e., shareholders, regarding the profitability of the business concern.
- ii. These systems help in planning and controlling capital and revenue expenditure.
- iii. These systems assist in receipt and payment of cheques relating to business transactions and carrying out other normal banking transactions.
- iv. They help in safeguarding and recordkeeping of business assets like tangible assets, intangible assets, fixed assets, current assets etc. With these systems it becomes easy to determine when to make an investment in these assets or replace assets.
- v. They assist in the maintenance of financial and other statutory records as per the laws enacted by the government.
- vi. Financial and Accounting Information Systems (FAIS) assist in the preparation of accounting statements and periodic reports relating to performance for internal and external control and audit.

# 2.5 Transaction Processing System (TPS)

Among the earliest computerized systems were the Transaction Processing Systems (TPS). They are the information systems which record the transactions carried out by the company. A transaction is defined as an exchange between two or more business entities. For instance, consider a garment manufacturing company. The company requires raw materials like cotton bales or nylon threads. It places orders for the raw materials with the suppliers. When raw materials are supplied and the suppliers receive the payments, only then has the company concluded a transaction with them. Similarly, the company enters into another transaction with the wholesalers to supply the finished products (i.e. the ready made clothes). The transactions – the quantity of raw materials received and the payment made and the quantity of goods supplied to the wholesalers and the payment received are recorded in the computerized records.

Along with it the names of the suppliers, wholesalers and the amount of tax etc., are also recorded. Such type of data is very useful in preparation of financial statements of the company. This data also acts as input for MIS and DSS. The transaction systems exist for various departments like marketing, production, accounting, human resources, engineering, etc. The companies are moving from isolated TPS for each department or unit towards cross-functional TPS to encourage free flow of information so that synergy can be achieved for the entire company.

The following are the steps in processing a Transaction:

i. **Data Entry:** The data related to the transaction must be initially entered into the system. In a computerized environment, the input devices are keyboard, scanners, mouse, etc. There are some documents which are created at the location where transaction occurs. Such documents are known as *source documents*. For instance, when a person draws money from the ATM, then the receipt generated by ATM becomes the source document for adjusting the current or savings account.

- ii. **Data Validation:** Data validation is an important step in transaction processing. The data entered must conform to the predetermined standards set while designing TPS. The two steps in validation are error detection and error correction. These two steps are performed by different sets of control mechanisms. Error detection involves checking the appropriate format (text, numbers etc.) of input data, length of the numeric data, validity of the data, consistency of the data, etc. Error correction steps involve correcting the errors found during error detection. Some error correction measures include allowing only authorized persons to correct data, modify data, update record and maintain the record of those persons who have carried out operations on the system.
- iii. Data Processing and Revalidation: After the accuracy and reliability standards are satisfied, then the data is ready for processing. The two methods by which transactions are processed are: Online and Batch Mode.
  - a. **Online Transaction Processing (OLTP):** In this type, the input devices are directly connected to the TPS. Hence, the processing is carried out instantaneously as and when the data is entered into the system. The input device may be at remote location and linked to the system by means of network or telecommunications. For example, individual PC systems act as input devices which are connected to a main server. Computer operators can enter data with the help of keyboards, mouse etc., using their PCs. Examples of online transaction processing are: ATM transactions, student registration for classes and order tracking. Flight reservation and railway reservation are other examples of OLTP. The computer operators with the help of their PCs connected to the main server can check the availability of seats and then book the tickets on an online real time basis.
  - b. Batch Processing: Unlike Online processing, batch processing accumulates the transactions over a period of time and the transactions are processed periodically. The transactions are processed daily, weekly or on monthly basis. For instance, the marketing executives may travel to various locations around the globe frequently. The company may accumulate these transactions and process them every month to make payments of travelling allowances. To carry out batch processing, there are two types of files. One is the transaction file and the other is the master file. As and when a transaction takes place, the information is recorded in the transaction size recorded in the transaction size corded in the transaction file.

The information is processed using techniques such as sorting, merging and so on. The master file is updated with information from transaction file. Master file is a permanent record of all transactions that have occurred. Whenever the master file is updated with the information from the transaction file, a new master file containing most recent transaction data is generated. As an example, the travelling expenses incurred by the marketing executives each time they travel to a foreign country are recorded in the transaction file. After a month, the total travelling expenses of each marketing executive is calculated and the respective record of the marketing executive in the master file is updated. Thus, master file contains all the information relating to the travel undertaken by each marketing executive for the previous month.

iv. **Data Storage:** After data is processed, it should be stored properly with all the security and privacy measures in place. The stored data may be useful for a number of purposes. It may be required by the government agencies, by the rating agencies, by the corporate customers or by the top management for decision-making purposes. Most of the data is stored on storage devices such as magnetic disks, floppy disks, compact disks and hard disks.

- v. **Output Generation:** After storing and processing the data collected from a number of sources, the output information for the decision makers is in the form of:
  - Documents and reports, and
  - Forms: screens or panels.

Document is usually a record of one transaction and report is a summary of two or more transactions. Documents can be presented after further processing or they can be presented in a different format. Examples of documents are invoices, pay checks, purchase invoices, sales receipts and job orders. A report for example may give information in a summarized form of all the invoices from a given supplier.

vi. Query Support: Query facility allows users to get data or information from the system based on their requirements. The user puts his query in the form of questions and gets answers to his questions. For instance, in the computerized railway reservation system working on an online real time basis, the computer operator or the user can query the system regarding the number of seats vacant till date. If the system responds by displaying the number of vacant seats then those seats can be booked accordingly. In another example, the shop floor manager may report the number of defective items produced everyday by entering data through a Personal Computer (PC), connected to the centralized database. The production manager, who is working in the corporate office, may query the system and find out the number of defective items produced in a given month.

#### 2.5.1 TRANSACTION PROCESSING METHODS

There are two ways in which transaction processing systems process data: (i) Batch processing, and (ii) Real time processing.

- i. **Batch Processing:** This involves the accumulation of transactions until a sufficient number have been reached. This makes processing more efficient. Depending on the volume of transactions, the processing of batches can be done on a daily, weekly, or monthly basis. This type of processing can be very helpful when the batches are processed in a sequential file.
- ii. **Real time Processing:** A real time processing capability enables transactions to be processed immediately after they are generated and provide immediate output to the end users. When the data entry is online, many errors can be corrected immediately because the person handling the transaction is available for making corrections. Moreover, online entry and processing provides instant results.

Each type of processing has its own relevance. For example, for a payroll system, there is hardly any need for online entry or processing, batch processing would thus be sufficient. In contrast, an airline reservation system spread across the country would require an online entry and processing system.

#### 2.6 Human Resource Management Information Systems

Men, machines and materials are the resources of an organization. An organization is identified by its employees. They are the ones who design the destiny of the organization. Employees are also one of the stakeholders of the business enterprise. It is the statutory and moral responsibility of an organization to look after the welfare of its employees and in turn they take over the tasks to be carried out in the organization in a responsible manner according to their designations, and also play an important role in its progress and development. An organization that understands the needs and aspirations of its employees and designs its policies accordingly will be rated very high in the job market by the prospective as well as present employees. Thus, the organization will have no difficulty in finding skilled manpower which will help it to build knowledge base and acquire competitive advantage. Employees are the external link of an organization with the rest of the

#### Introduction to Information Systems

world. Employees can form a communication network for spreading the name and fame of the organization. Along with managing other resources (i.e., financial resources, machines, materials etc.), an organization has to design an efficient information system which will not only identify and reward high performers but also provide ample scope for the employees to showcase their existing skills and also learn new skills so that they can contribute positively to increase the productivity of the organization.

Human Resource Management Information System (HRMIS) has the following broad objectives:

- To support wage and salary administration,
- To facilitate selection and appointments,
- To help identify high potential people,
- To determine in-company promotion,
- To help in the administration of management development and training, and
- To help and develop full potential of employees and department.

Human Resource Management Information Systems (HRMIS) can be used for carrying out the following tasks:

- i. **Staffing the Organization:** Storing personal details of individual employees that can be used for generating pay slips, identity cards and for other references. In addition, personnel database can be updated with the information relating to changes in job assignments and compensation, or hiring and terminations. An employee skill inventory system uses personnel database of the employees to find out employees with particular skills so that they can be appointed to accomplish specific assignments and projects. Another task relates to manpower forecasting and planning required to meet the future expansion and diversification plans of the organization.
- ii. **Training and Development:** Decision-making activities are carried out in the areas of:
  - Recruitment and selection.
  - Employment, including promotion, transfers, disciplinary procedures, termination and redundancy.
  - Education and training which includes computer-based multimedia training programs and appraisals of employee job performance.
- iii. Compensation Analysis: Information systems help to analyze the range and distribution of employee compensation (wages, salaries, incentive payments and fringe benefits). In addition, a comparison of compensation of employees in similar organizations is carried out to attract talented people with requisite skills. Thus, this will help the company to develop a competitive and equitable compensation plan, to negotiate with labor unions and also to cut compensation costs.
- iv. **Governmental Reporting:** In an organization the Human Resource Department (HRD) has to prepare reports to be submitted to government agencies. Computer-based information systems help the Human resource department to undertake statistical procedures and methods and produce reports in desired formats in accordance with the rules and regulations.

The employee database consists a number of files. The files may be related to the old employees, newly recruited employees who are undergoing training, employees who are about to be promoted, employees compensation and benefits, present skills of the employees and description of skills that the company may require, list of employees whose services are terminated and the reasons for doing so etc. Each file contains records of individual employees with data fields like

employee name, address, employee number, number of years of service, training undergone, etc. These files may be helpful for generating reports about employees and future requirement of manpower for the organization. These reports form the basis for decision-making by the top management.

# 2.6.1 DESIGN OF HUMAN RESOURCE MANAGEMENT INFORMATION SYSTEMS

The design of Human Resource Management Information Systems (HRMIS) for any organization depends on a number of factors. The most important factor is the size of the organization. An organization whose size is very big (like multinational companies) has thousands of employees working in different geographical regions whereas a domestic organization has its area of operation limited to a few regions of a country and has only a few hundred employees. Thus, the complexity of computer based information systems depends upon the size and spread of the organization.

Before designing the system, the organization has to identify the information requirements. It should decide as to what decisions it is going to make about individuals or group of employees. For instance, in an educational institution the management takes the decisions on the matters of promotion, compensation of employees (faculty) on the basis of their educational qualification, their teaching experience and research papers presented in the journals of national and international repute. On the other hand, a manufacturing organization has major part of its employee strength engaged in producing goods and services. Therefore it has to take decision about its employees on the basis of their technical skill, their productivity, skill in operating machines and producing goods etc. Thus, the information needs of organizations depend on their respective functions.

As with other information systems, HRMIS has to collect data, which for the most part comes from its internal sources. The data which can be obtained from individual employees is as follows:

- The application form, which provides personal particulars.
- Interview and test record.
- Job history after joining the firm including details of transfers, promotions and changes in occupation.
- Current pay details and changes in salary or pay.

Education and training record with details of courses attended and results obtained.

- Details or performance assessments and reports from appraisal or counseling sessions.
- Absence, lateness, accident, medical and disciplinary records with details of formal warnings and suspensions.
- Holiday entitlement.
- Pension data.
- Termination record, with details of exit interview and suitability for re-engagement.

The analysis of the above data will help the management in determining the contribution of each individual employee towards the growth and development of the organization. It will also help in evaluating the skill set, education, effort and motivation levels of individual employees. The above data can be used to formulate matters of development, training, education and compensation of the individual employees. Thus, the decisions that are taken for one employee may be different from that to be taken for another employee. In addition, management has to take into account, the matters related to the total manpower requirement in the organization. The data of individual employees when viewed in collective sense will enable it to develop proper policies, programs and procedures to develop existing human resource and also attract potential employees. The

organization can prevent discontent among its employees and reduce employee turnover. It can identify the general skill set among its employees and introduce programs like job enrichment and job rotation. The important sources of collective information are as follows:

- Numbers, grades and occupations of employees;
- Absenteeism and data on lateness;
- Accident rates;
- Age and length of service distribution;
- Total wage and salary bill;
- Wage rates and salary levels;
- Employee costs;
- Overtime statistics;
- Records of grievances and disputes; and
- Training records.

# 2.7 Inter-organizational Information Systems

Inter-organizational information systems refers to the use of Internet, Extranets and other networks to establish electronic linkages between the computers of a business organization with its customers and suppliers so as to develop new business alliances and partnerships. As part of its business activity, a firm has to receive and send information to its suppliers, customers and also other firms relating to the design of customer-specific product, order booking, transmission of invoices, making payments and after-sale servicing of products. These systems are designed to support these activities electronically. They are designed and developed by industry-specific trade groups for the mutual benefit and convenience of industry members and to focus their efforts on the products and services produced by their industry.

Inter-organizational information system is an element of Business-to-Business (B2B) Electronic commerce. As the name suggests, this information system spans over more than one organization and ensures economic efficiency for the organizations concerned. This helps in gaining competitive advantage and also helps in evolving business strategies consistent with emerging technologies. For example, by establishing electronic linkage with suppliers, the inventory of the company will be replenished automatically using inventory replenishment systems as and when the inventory levels of the company go down below a predetermined level. This will save time and resources of the company in terms of monitoring its inventory levels and placing of orders. A real life example of inventory replenishment system was introduced by Proctor & Gamble to automatically replenish Wal-Mart's in-store stock with the products. Another example of such a linkage is the Electronic Data Interchange (EDI). EDI can be used for entering orders, sending confirmations, transmitting bills and also funds. Companies use extranets or other private networks to provide detailed information on products, warranties, customer service, contact addresses and to answer Frequently Asked Questions (FAQs).

Inter-organizational Information Systems (IOS) helps businesses to establish strong bonds with customers and suppliers by entering into new relationships. This will neutralize competitors and competition because customers and suppliers will find it difficult either to abandon existing businesses or to accept other trade contracts. Businesses will find considerable improvement in distribution, marketing, sales and service activities. Inter-organizational information systems is one of the innovative applications of IT. With Inter-organizational information

systems, companies are able to reduce cycle time. Hence, Cycle Time Reduction (CTR) has become one of the key goals of organizations.

Inter-organizational information systems is applied in the complex areas involving the integration of ERP packages and supply chain management. Inter-organizational information systems form are a part of the virtual organization approaches, in which major aspects of core business processes such as design, production and delivery are outsourced to other organizations having expertise in those areas. Virtual organizations exist due to well developed inter-organizational information systems since inter-organizational information systems has made it possible for companies to communicate with each other without the need for any physical presence of employees. For instance, inter-organizational information systems makes it possible for a company to inquire about the status of its order placed with a computer manufacturer and take the delivery of computer hardware from the warehouse at an appropriate time through telecommunications network.

# **3. ORGANIZATIONS**

An organization is a group of large number of individuals who have a well-defined set of relationship related to authority. They have come together to achieve a set of common goals. The major subsystems of an organization are the departments, programs, teams, divisions etc. Every subsystem has a way of carrying out the things assigned to it. There are plans, policies and procedures for accomplishing the things. It is necessary that people, who form a part of the organization, should give more preference to the accomplishment of organizational goals rather than their individual goals. We can define an organization as system of resources structured by power centers to achieve some purpose within some environment. In the given definition,

- System is that which accepts inputs and gives outputs.
- Resources are in the form of money, material, manpower and knowledge.
- Structure denotes the resources configured in some non-random manner in static or dynamic manner. Power centers are the persons who wield authority and they also select and allocate resources.
- Purpose is achieved when managers work to bring the system consistent with purpose/goals.
- Environment is always changing and both the environment and the organization affect each other.

A large number of organizations exist in industrially developed countries which have an influence on most of the activities of human life. For most of the time, one can find a relationship between the growth of an organization and the influence of bureaucratic tendencies. Business organizations may have two or more than two (may also run into thousands) people.

Following are the important aspects one needs to consider about the business organizations:

- i. **Vision:** Vision denotes the image about the organizations and the way it should work in the minds of the people associated with an organization. It also denotes the features that an organization should present when everything is fine for it.
- ii. **Mission:** The ultimate purpose for the existence of an organization is its mission.
- iii. **Values:** Values are the priorities on the basis of which the activities are carried out in an organization. These values depict the personality or culture of the organization.

- iv. **Strategic Goals:** They denote the targets that need to be achieved. These targets determine the overall existence of an organization and its progress over a period of time, usually five to ten years. Mission guides an organization towards its goals.
- v. **Strategy:** The general approach taken by an organization to reach its goals is known as strategy.

# 3.1 Organizational System

Organizations can be considered as systems. A system is an organized collection of interrelated and highly integrated parts. These parts work together to achieve a goal which pertains to the entire organization. The system requires inputs which are processed by the processing system resulting in outputs. The production of outputs in a desired manner can be considered to be the achievement of the goal. In addition to processing inputs and producing outputs we also have a feedback mechanism that brings to light any deviations in the path or procedure so that corrective action can be initiated. Organizations can be considered to be social systems.

Resources such as raw materials, money, technologies and people are the inputs to an organization. The inputs are grouped into various groups. These groups, even though they have their own agenda, work in tandem in a careful and coordinated manner to achieve the goals set for the system. The outputs produced by an organization may be in the form of tangible goods, commonly known as products or intangible services. The other stakeholders of an organization are the employees who are paid for the work that they do according to their designation and the customers for whose benefit the organization exists. The very existence of a business organization depends on the customers and their preference for the goods and services it makes available. The feedback to an organization comes from the employees who give their valuable suggestions and technical expertise for the improvement of processes, from the customers whose opinion is sought by the organizations for improving their existing products and services and for introducing new products and services, when the government, introduces new legislations, the press which carries reports about the organization and also the improvements in the technology is nothing but the feedback.

An organization also has a number of subsystems which have their own inputs, processes, outputs and boundaries of operation. Subsystems are organized in an hierarchical manner in order to achieve the goals of the system. The organizational system works within the legal environment of a country and thus has legal documents denoting its existence. There is also an organizational chart which shows the designations and job descriptions.

# 4. MANAGEMENT AND STRATEGY

Strategic management is both an art and science. It involves the formulation, implementation and evaluation of functional decisions involving more than one functional area so that the objectives of an organization can be achieved. The process of strategic management consists of specifying the objectives, and setting aside resources to implement the policies and plans. Since strategic management takes into account the whole organization, it combines the activities of the various functional areas of a business for achieving organizational objectives. The process of strategic management consists three main processes: Strategy formulation, strategy implementation, and strategy evaluation. In strategic formulation, the objectives of an organization are set; as also its mission and vision statements are set. The objectives of Strategic Business Units (SBUs) are also set. Which are set based on the strategic plan of action based on the analysis of the situation.

In strategy implementation, resources in the form of finance, personnel, time and technological devices are allocated for achieving the objectives set. A chain of commands is also established by assigning responsibilities of tasks to individuals or groups. While implementing the plan of action, previous results, best practices and benchmarks are also considered. Strategy evaluation consists determining how effective is the strategy that has been implemented. Corrective actions, if any, are taken for the future.

Individuals who determine the success or failure of an organization through their policies, plans and procedures are known as strategists. They formulate strategies. The top management personnel are responsible for formulating strategies. In a general sense, any manager who has the responsibility for profit and loss outcomes or has a commanding authority over a part of the business is a strategist or a strategic manager.

Their designations are termed as Chief executive officer, president, chairman of the board, executive director in the field of business organizations and vicechancellor, dean, in case of educational institutions. The work of the strategists is to collect information related to the environment in which the business is operating, analyze that information and organize it in such a manner so that it will help in determining the business scenario in future. They make use of forecasting models and scenario analysis, track industry and competitive trends, evaluate corporate and divisional performance, undertake SWOT (Strengths, Weaknesses, Opportunities and Threats), and finally prepare action plans. However, the strategic decisions taken by the strategists are highly unstructured. It cannot be predicted with certainty the results of these decisions. Being at the topmost hierarchy of the management, strategists have high degree of authority for making decisions about the organization. It should be remembered that strategies vary from one organizations to the other. The strategies are dependent on the general attitude, values, ethics, attitude towards risk, sensitivity towards social responsibility, preference either for profitability or wealth maximization, and short-term versus long-term perspective of the business.

# 4.1 Advantages of Strategic Management

Following are the advantages of Strategic management:

- i. Strategic management helps a firm to be proactive in dealing with outside environment. Instead of waiting for an opportunity to come its way, a firm initiates and influences the environment through its actions.
- ii. Strategic management helps to improve productivity, profit and sales.
- iii. An organization is better able to cope with the disasters and threats when it has already formulated strategic policies and programs.
- iv. Employee productivity can be increased through greater participation of the employees in the decision-making process. Employees would have clear understanding of the tasks expected of them to be completed. They can better understand the relationship between performance and reward.
- v. Firms with adequate planning systems that are geared towards the theory of strategic management display a greater degree of long-term financial performance relative to other firms in their industry.
- vi. Strategic management not only empowers managers and employees but also puts in place order and discipline. Otherwise, a firm will not be able to seize opportunities.
- vii. Organizations without any strategic planning make the mistake of underestimating their competitors' strengths and overestimating their own strengths. They put the blame for poor performance to factors that are not in their control such as the downslide of the economy, changes in technology or competition from MNCs (Multinational Corporations).

viii. Strategic management helps to reduce resistance to change, employee productivity and unrest due to ambiguity of goals to be achieved. It increases the capabilities of an organization in preventing the growth and occurrence of problems right at their origin itself. This can be achieved by promoting cooperation among managers at all divisional and functional levels.

# 4.2 Strategies and Policies

Strategies and policies are closely related terms. They provide a direction or a sense of purpose to an organization. They form the basis for operational plans and influence the other areas of management.

Strategy refers to the determination of the mission (or purpose), and the basic long-term objectives of an enterprise and the adoption of courses of action and allocation of resources necessary to achieve these aims.

*Policies* are general concepts or statements that guide managers' thought processes and behaviors when they make decisions. Policies are framed to make sure that managerial decisions are made within defined parameters. Although it is not essential that policies be necessarily followed in action; they serve as guides to ensure that managers remain committed to the decisions they have made.

Though the above statements give different definitions for the terms strategy and policy, it is possible that they mean the same thing in certain instances. For example, a company may plan to develop new products that fit into its marketing plan, as an essential element of the company's strategy. In the same way, a company's plans to distribute only through retail outlets, may be an essential element of its strategy. While growth through acquisitions may be the policy of one company, expanding the present market or product line may be the policy of another firm. Although, the above examples can be considered as policies they are also crucial components of major strategies. Thus, one logical way to distinguish between policies and strategies is that while policies are guidelines which help a manager in decision-making, strategy requires the organization to commit its resources in specific direction.

## 4.2.1 NATURE AND PURPOSE OF STRATEGIES AND POLICIES

The nature and purpose of strategies and policies are as follows:

- The key function of strategies and policies is to give a specific direction to plans. They serve as a guide to the achievement of organizational goals. Strategies and policies influence an organization's progress and growth. They try to provide answers to some vital and crucial questions such as (a) What business are we in? (b) What business should we be in? (c) Who are our customers? etc.
- ii. Strategies and policies help managers to prepare plans. They are equally helpful in guiding operational decisions. The basic principle of the strategy and policy framework states that the more clearly strategies and policies are understood and implemented in practice, the more effective and consistent will be the framework for enterprise planning. For instance, if the introduction of new products into the market is the major policy of a company, it will allocate more resources to research and development activities, and this is in turn reflects in its budget preparation.
- iii. In order to be effective, an organization must put its strategies and policies into practice through plans. Tactics are the action plans with the help of which organizations execute their strategies. Further, if strategies are to be effective, they must be supported by effective tactics.
- iv. Strategies and policies affect planning. As planning is the initial step in the management process, other areas of management are also greatly influenced by the predetermined strategies and policies. For instance, major policies and strategies influence the organizational structure, and these in turn influence the other functions of a manager.

# 4.3 Information Technology for Strategic Advantage

Businesses can use Information Technology to achieve strategic advantage by improving production methods and in the development of new products and services. For example, many countries have rules prohibiting the transfer of data across their boundaries. Others severely restrict, tax or prohibit import of hardware and software. Certain countries have local content laws that specify the portion of the value of a product that must be added in that country if it is to be sold there. Such regulations pose a serious challenge to global IT managements.

The geographical challenges which affect international business are referred to as geoeconomic challenges. Due to the unavailability of quality telecommunciation equipments and services in many countries, it becomes difficult to achieve real time communication across countries. Problems also arise because of the huge differences in cost of living and labor costs in various countries. Global IT initiatives should address such geoeconomic challenges effectively. While developing global business and IT strategies, it is important for managers to take into account the cultural, political and geoeconomic differences in the international community. Cultural challenges facing global businesses include differences in languages, cultural interests, religions, customs, social attitudes and political philosophies. Information System managers must be trained and sensitized to such cultural differences before they are sent abroad or brought into a corporation's home country. Other cultural challenges include differences in work styles and business relationships. These issues need to be addressed, and resolved on a continuous basis.

# **4.3.1 IMPROVING BUSINESS PROCESSES**

Information technology can be used to develop products, services, and other capabilities that will enable companies to achieve strategic advantage. The use of IT helps streamline the operational and managerial processes. Improvements in business processes can help the organization to cut costs, improve quality, and customer service and develop innovative products. The process of manufacturing can be automated and improvements can be made using computer-aided design, engineering production, and manufacturing resource management technologies. In the automobile sector, IT can be used for connecting manufacturers with dealers and suppliers. These organizations can use intranet, extranets and other networks to interact within and outside the organization. Improving business processes will enable manufacturers to improve production, distribution and sales.

#### 4.3.2 BUSINESS PROCESS RE-ENGINEERING (BPR)

Business process re-engineering refers to radically changing the design of business processes to improve performance and efficiency. Such redesign will enable improvements in terms of costs, quality, speed and service. Business process re-engineering is concerned with redesigning business processes on a large-scale. It is applied to strategic business processes. BPR can be achieved through the use of Information Technology (IT) and by redesigning the organizing. In achieving business process re-engineering, sacrifices in the form of existing job cuts/job redesign and also the ability to sustain the risk of failure. But the potential returns are many times higher in the form of new jobs.

IT plays a very important role in the implementation of re-engineering in business organizations. Information technology can help improve procurement function in an organization. It also ensures greater collaboration and communication among people in the organization.

There are three levels in BPR:

• The first level involves the identification of activities, which are time consuming or performed inefficiently. Making these processes IT enabled, could solve the problem.

- The second level involves relating business activities to external entities like customers, suppliers, and business partners. At this level, the aim is to eliminate redundancy, redeployment of inventory and showing information. This will help improve the interaction among different business entities.
- The third level involves the application of the principles of re-engineering by seeking answers to questions like: What will be the effect of eliminating a particular step? Can it be used in combination with another process? Can an IT tool improve efficiency etc. The existing processes are totally discarded and new process design developed to adapt to the transformation. At this stage, the business process is fully transformed. However, it is important to review and monitor the progress of the new system.

Although, BPR can bring about dramatic improvements in efficiency, its acceptability is likely to be low, as it is perceived a threat to authority and job security.

The principles of BPR are given below:

- i. **Organize around Outcomes, not Task:** There stress should be on the result of a particular process and the way it is performed. Instead of the task undertaken, its result or outcome is given importance.
- ii. **Generation of Output:** The design of information systems should be such that the person who requires the output should be able to generate it.
- iii. **Integration of Information Systems into Existing Processes:** It is not required to have a separate set of activities/operations for BPR. The only requirement is that the current activities should be IT enabled.
- iv. **Centralization and Access of Data:** Even though the data be stored in a central location, it should be accessible to all concerned through networks.
- v. **Avoidance of Redundancy:** In order to prevent redundancy, repetitive tasks should be grouped together under a single system.
- vi. **Decision-making at the Source of the Work:** The basics of decision-making should be detailed in unambiguous manner and all the available information should be provided so that the person who makes decisions is not delayed in his work.
- vii. **Centralization of Information:** The information various departments, branches or individuals require should be stored at a single place and those who need it should be given limited access rights to the information storage area. This will not only maintain confidentiality but also avoid replication of information at several places.

# **4.3.3 BECOMING AN AGILE COMPETITOR**

Agility in context of business is the ability to adapt to the rapidly changing business environment. To compete in global markets, high quality products/ services are essential. The attributes that best describe an agile company are broad product range, customized products, short model life cycle and process orders in large numbers. The four fundamental strategies of an agile competitor are:

- To produce products and services that serve customer requirements. In this context, product pricing is important. Pricing should be based on value to customer rather than on cost of production.
- Maintain cordial relationship both within the organization and with competitors. This will be useful in rolling out new products at regular intervals.
- Maintain flexible organizational structure so that it can adapt quickly to change.
- Foster entrepreneurial skills and empower employees by rewarding them for good performance. This improves employee adaptability and creativity.

# 4.4 Strategic Applications of Internet

Internet can be used to gain competitive advantage. In the absence of Internet, companies would have been confined to only a few avenues of information and trade. Not only does it help in accessing information, but it also serves as a good communicating and trading tool. The following are the advantages of using Internet:

- **Cost and Efficiency Improvements:** When the internal drivers are low and external drivers are high, an appropriate strategy would be to use Internet and World Wide Web (www) to improve efficiencies. For example, using e-mail to communicate with suppliers, dealers and business partners.
- **Performance Improvements in Business Effectiveness:** When internal drivers are high and external drivers are low, the appropriate strategy would be the use of intranets to improve collaboration within the organization.
- **Global Market Penetration:** When a company needs to optimize customer and competitor connectivity and use of IT, the strategy could be to use Internet based applications to facilitate customer interaction.
- **Product and Service Automation:** When there is a network of customers, suppliers and competitors, it is better to apply the Internet technologies throughout the company including business relationships and operations. Using OLTP (Online Transaction Processing) and EDI (Electronic Data Interchange) would be useful in such a situation.

# **5. ELECTRONIC COMMERCE**

The society in general and the economy in particular is undergoing change due to the growth of IT and technological sophistication of information technology and communications. In present times, computers and other electronic devices are commonly found communicating and interacting directly with other communication equipment over different networks, such as the Internet, LANs, WANs and MANs. Business organizations and consumers have realized the potential and the benefits of implementing and using the latest computer-enabled networks.

In this digital age, consumers are routinely using computer networks to search for sellers, evaluate products and services through multimedia presentations and selecting products after comparing prices. Businesses are not far behind; they are using networks on a wide scale to develop and re-engineer product and production processes, narrow down the procurement processes, discover new markets on a wide geographical area and bring their products to the doorsteps of new customers, in addition to managing their internal operations, logistics and inventory.

The use of electronics and IT has attracted new investments from venture capitalists which have resulted in the addition of production facilities, hardware, software, services, and human resources. In the ultimate analysis, this change may not only better the performance of developed economies of the western countries but also the developing countries. This has all been possible due to the introduction of computers on a wide commercial scale for over two generations.

The terms Internet, electronic commerce, electronic business, and cybertrade have now become commonly used terms. However, they are used interchangeably and with no knowledge about the relationship between these terms. Electronic and non-electronic businesses share an infrastructure based on the available economic resources that include natural resources, utilities, structures, equipment, telecommunication and other services and also the skills of the employees. The economy that takes the assistance of electronic devices and technologies can be considered as having three primary components – supporting infrastructure, Electronic Business (E-Business) consisting the way business is conducted and Electronic Commerce (E-Commerce) consisting buying and selling. Out of the total economic infrastructure, E-business infrastructure is that which is used to assist electronic business processes and undertake E-commerce transactions. This infrastructure considers hardware, software, telecommunication networks, support services and also the knowledge and skills contributed by the professionals helpful in electronic business and commerce. The E-business infrastructure includes the following:

- Computers, routers and other hardware;
- Satellite, optical communication and network channels;
- Application and System software;
- Other support services such as developing a website, electronic payment and certifying the transactions; and
- Human resources such as programmers and managerial staff.

Business transactions and commercial activity have been a part of human civilization from ancient times. From the dawn of human civilization, buying and selling of goods and import/export activities have resulted in cultural exchanges and lasting influences on different civilizations of the world. Before the advent of science and technology, all work related to buying/selling of goods, ordering of goods, accounting, delivery of goods, etc., was carried out manually. Even though there is enough evidence to suggest that export and import activities were carried out between geographically dispersed civilizations, the scope of such activities was limited due to physical and manual constraints. With industrialization and developments in the field of science and technology, it was possible to carry out commercial activities on a large scale within a very short time. Advancements in the field of information technology, electronics and Computer science and technology have contributed immensely to the field of commerce and business. Business houses which were once limited to a particular region or country found that technology can enable them to reach global customers. Commercial activities which were once carried out manually are now being carried out electronically. This has helped organizations to reach millions of customers because numerical computations and record keeping in business which would take hundreds of years even for a large number of people, working together would now be performed by high speed computers within seconds. Even though all procedures and methods are similar in E-commerce, they are automated such that human intervention is minimized in those operations which are routine and repetitive. Electronic Commerce or E-Commerce has found an enviable place in the corridors of small and big and also local and multinational business organizations. It has reduced time, money and physical resources involved in carrying out commercial activities to a large extent.

In E-Commerce, most of the business transactions are executed electronically between parties such as companies (business-to-business), companies and consumers (business-to-consumer), business and public sector, and consumers and the public sector. The use of telecommunications networks, computers, World Wide Web (WWW), Internet and Intranet and other information technology systems have helped E-Commerce as the preferred way to carry out business transactions. In E-Commerce, companies can sell their products directly to the customers through websites. In addition, all the secure transactions between one company and the other can be carried out by means of E-Commerce.

Following are some of the common examples of E-commerce transactions:

- A student purchases a textbook on the Internet from a virtual shop hosted through a website.
- A business executive reserves a hotel room through the Internet accessing the website of the hotel.

- A customer (individual or corporate) calls a toll free number and places an order for a computer connected to the seller's interactive telephone system.
- A business organization buys office equipment online or through an electronic auction.
- A retailer places an order for merchandise using an Electronic Data Interchange (EDI) network or through the supplier's extranet.
- A manufacturing plant places a requisition order for electronic components with another plant within the same company using the company's intranet.
- An individual withdraws funds from an Automatic Teller Machine (ATM) instead of visiting a physical branch of a bank.

In the next section, we shall see some of the definitions of E-Commerce as given by leading organizations of the world which will help us understand its scope in a better way.

# 5.1 Definition of E-Commerce

The following are the definitions of E-Commerce as given by various groups and organizations:

- i. **OECD** (Organization for Economic Cooperation and Development, 1997): E-Commerce refers generally to all the forms of transactions related to commercial activities, including both organizations and individuals that are based upon the processing and transmission of digitized data including text, sound and visual images.
- ii. **European Commission, 1997:** Electronic Commerce is about doing business electronically. It is based on the electronic processing and transmission of the data, including text, sound, and video. It encompasses many diverse activities including electronic trading of goods and services, online delivery of digital content, electronic fund transfers, electronic share trading, electronic bills of landing, commercial auctions, collaborative design and engineering, online sourcing, public procurement, direct consumer marketing, and after sales service. It involves both products (for example, consumer goods, specialized medical equipment) and services (for example, information services, financial and legal services); traditional activities (for example, health care, education), and new activities (for example, virtual malls).
- iii. **Garter Group:** Electronic Commerce is an electronic communication among enterprises, including customers, suppliers, business partners, government organizations, and financial institutions.
- iv. **EITO, 1997:** E-Commerce is the carrying out of business activities that lead to an exchange of value across telecommunication networks.
- v. **ECOM, 1996:** E-Commerce supports an entire range of activities such as product design, manufacturing, advertising, commercial transactions, settlements of accounts using a variety of computer networks.

# 5.2 Elements of E-Commerce

In any commercial activity, the important players are:

- **Buyers:** Buyers are individuals or organizations having necessary financial resources and who are willing to purchase goods and services.
- Sellers: Sellers are the people or organizations who offer their goods and services to buyers in return for money. The different kinds of sellers are retailers who sell to the ultimate consumers, Wholesalers or distributors who sell to retailers. Wholesalers or distributors buy their goods from the manufacturers or producers.
• **Producers:** Producers are the people or organizations who are responsible for developing or creating the products and services. These products and services are sold by the sellers to the buyers. Since producers sell their products to the Wholesalers or distributors they may be classified in the category of sellers.

The elements that are found in the domain of E-Commerce are no different from those found in ordinary commerce. However, due to the introduction of electronic devices and IT, there are slight variations in the real life situations where E-Commerce activities are carried out. The following are the typical elements of E-Commerce activity.

- i. **A Product or Service:** As in any commercial activity, a product or service is present to carry out the buying or selling process. However, neither the seller can display a tangible product nor the buyer can sense the product. Only the virtual product or service along with its features is displayed with the help of multimedia presentation on the web page.
- ii. A Place to Sell the Product: A shop or commercial establishment is a place where the product is generally sold. In the case of E-Commerce, the website acts as the host for seller to displays the product and the buyer can see and know about it.
- iii. Address of the Website: In case of E-Commerce, the buyer uses search engines and linkages from other websites to find out the address of that website which hosts the products and services that he wants to buy. Address of website can be advertised in the print and visual media also.
- iv. **Method of Accepting Customer Orders:** At the website, a shopping cart is provided for the customers to add their selected products. After clicking the icon and filling up the shopping cart, the products to be ordered for ultimate purchase are confirmed. This electronic order form reaches the company's database so that it can carry out the delivery process.
- v. Method of Payment for Goods Purchased: The buyers and sellers are not in direct contact with each other. Therefore, payment in E-Commerce is done using Electronic Fund Transfer by means of credit cards, smart cards, E-checks, net banking etc. The information about payment is routed through Value Added Networks (VANs) and Payment Gateway Systems, etc. However, for those customers who do not wish to pay electronically, the companies collect the payment at door step of the customers after delivering the goods.
- vi. Actual Delivery of Goods: After the order is processed, the goods are physically delivered to the address of the customers mentioned in the order form. The manufacturers or the companies have their own logistic network which carries out the physical delivery of goods.
- vii. Acceptance of Returns: As in case of ordinary commerce, the companies have their network to accept the returns from those customers who are not satisfied with the actual performance of the goods because of some defects in the goods or due to substandard quality of the goods.
- viii. **Handling Warranty Claims:** If the goods are found to be ineffective in carrying out the required task, are broken while in transit or have some inherent problems which are found out within the warranty period, then the company has to handle the warranty claims as done in normal business activities.
- ix. **Customer Service:** There are a number of facilities on the website which are designed for customer service. Some of them are the facility to know the status of order from the date it is sent, facility to register complaints, facility to chat online with company officials, facility of FAQs (Frequently Asked Questions) on the product, facility to send E-mail, facility of on-line knowledge bases, etc.

## 5.3 Models of E-Commerce

There are two main categories into which all the transactions in E-Commerce may be classified. They are:

- (i) Business-to-Consumer (B2C) and (ii) Business-to-Business (B2B).
- i. Business-to-Consumer (B2C): Majority of E-Commerce transactions involve business organizations and individual customers. A large number of companies not only sell their products physically but they also sell them virtually through their websites. In addition, there are certain companies which exist virtually to sell products of wide variety and different brands. These companies do not manufacture any goods. They have a website with a domain name where they host different products and brands. In B2C E-Commerce transactions, thousands of customers from all over the world visit the website and buy the products. The customers can visit a number of such websites, study the features of the products, compare their prices and make the buying decisions at the click of the button using Internet. They can buy the goods from any part of the world by sitting before their computer system. However, the consumers are deprived of physically touching and seeing the products and also bargaining for the price of the goods.
- Business-to-Business (B2B): These transactions involve one or more ii. business organizations or corporations. For instance, most of the transactions involve bulk purchases between the company and its suppliers. These transactions are similar to B2C transactions, but there are differences in characteristics, technologies and in the business drivers for adopting E-Commerce. Most of these transactions are carried out using secured networks between the companies which remain inaccessible to others due to security and confidential matters. Unlike B2C transaction, the buyers and sellers are registered with each other. They have access to the business needs of each other. For instance, the suppliers have access to the inventory database of the company so that when the inventory levels fall to a certain level then they will replenish to the desired level without the need for formal orders from the company. This will greatly save time and money and also reduce the cost of stationery. Such transactions are carried out through highly developed security networks with firewalls to prevent unauthorized access.

# 5.4 Benefits of E-Commerce

The following are the important benefits of E-Commerce:

- i. The cost of transactions carried out through E-Commerce is very low when compared to the ordinary commercial activity. Thus, both the buyers and sellers benefit due to lower costs.
- ii. E-Commerce provides many benefits to the buyers. They can buy the goods from any part of the world from the convenience of their houses or offices at any time of the day. This minimizes the traveling expenses and saves time. In addition, the customer can compare prices of goods offered in different countries which will help him to make a better deal.
- iii. E-Commerce helps individuals and organizations to make bulk purchases in a single transaction. They are free from long queues and logistic constraints in making bulk purchases. They can choose wide variety of goods, vendors, brands and manufacturers from around the globe in the shortest possible time. Multimedia facility helps them to view the actual working of the product.
- iv. E-Commerce helps the sellers to reduce costs and pass on the benefit of lower prices to the customers. They can display wide variety of goods and their features virtually without worrying about the infrastructural facilities. Other costs like advertisement and promotion can be cut down because the website plays the dual role of displaying and advertising the product. Companies can offer genuine discounts on their products.

- v. For big organizations, B2B transactions help to develop standardize procedures, policies and technology in dealing with their suppliers and clients. Long-term strategic relationships can be developed in the business community. Procurement costs can be lowered to a great extent. Customer service can be improved without incurring additional costs. The companies can also develop customer databases which will help them in market segmentation.
- vi. Internet has opened new gateways for the development of E-Commerce. Using the medium of Internet, companies have overcome the constraint of size in carrying out business activities. Thus, barriers to enter new markets are minimized through Internet. This increases competition and enhances the quality of goods and services. The presence of the company on the Internet enhances the image because it is possible to reach large number of people through Internet.

# 5.5 Constraints in the Way of E-Commerce

The following are the issues and impediments which are found to hamper the growth of E-Commerce:

- Security: Security concerns are hampering the growth and development of E-Commerce all over the world. Websites of the companies often crash due to hacking, defacing and other illegal activities carried out through electronic and other means by anti-social elements.
- ii. Cost: The cost elements involved in the implementation of E-Commerce are:
  - a. **Connection:** The Company has to lease bandwidth lines from the Internet Service Providers (ISPs). In addition, the company has to develop its own website and register for domain names.
  - b. **Hardware/Software:** The hardware costs include costs of computer systems, modem, routers etc. Similarly, the company has to either procure or develop in-house software for utilizing the website.
  - c. **Set-up:** In order to install E-Commerce systems, the costs involved are the employees salaries and wages which the company has to bear.
  - d. **Maintenance:** The employees have to be trained so that they will be able to carry out Internet based commercial transactions. In addition there should be regular upgradation of existing systems to make it compatible with the changed business circumstances.
- iii. Legal Issues: Law related to IT and commerce is not standard in all the countries across the world. Therefore, legal judgments pronounced in one country are not applicable in other countries. Website is a medium of conducting business for the company without any boundaries. The companies and the customers for instance may be reluctant to carry out the business transactions because of the apprehensions in their minds about the laws related to intellectual property, data privacy and security etc., in other countries. Thus, a number of different legal issues may arise in the matters of business transactions in different countries. This is a significant roadblock in the development of E-Commerce.
- iv. Lack of Skilled Personnel: E-Commerce technologies and their implementation are in the stage of infancy in most of the business organizations. There are not many skilled personnel who can handle the tasks of setting up E-Commerce systems, its security related environment and other matters of interest. Research and development work is still being carried out to improve E-Commerce and its associated business systems.

v. Uncertainty and Lack of Information: Companies see Internet and websites as a tool for marketing and public relations. Small and medium sized companies which have not felt the need to use electronic means of communication with their customers and suppliers are ignorant about its potential benefits. Management is also reluctant to implement E-Commerce systems due to lack of proper advice, resources (financial and infrastructural) and counseling.

# 5.6 E-Commerce Standards

The following are the standards of E-Commerce:

- Electronic Data Interchange (EDI): It refers to the exchange of business i transaction documents using directly linked computers between two organizations. The examples of such documents are invoices, bills of landing or purchase orders. EDI transmits an actual structured document/transaction with well defined fields such as transaction date, transaction amount, sender's name, recipient's name etc. EDI eliminates manual transaction, printing of data on the paper based documents and its handling by human couriers. It is cost effective because it facilitates the automatic transmission of standard business documents from one information system to another with the help of telecommunication network. A company can develop long-term strategic business relationships with customers, suppliers and business partners because they find it easy to place/receive orders from the company. Companies are enhancing the benefits derived from EDI by integrating the data supplied by EDI with applications such as accounts payable, inventory control, shipping, and production planning. Companies have to standardize the procedures of transactions and verification process with other firms so that legal requirements are satisfied. Some organizations use private networks for EDI while others use Internet for this purpose.
- ii. Open Buying on the Internet (OBI): OBI standard is created by the Internet purchasing round table. The purpose of this standard is to make it possible for different E-Commerce systems to talk to one another. This standard was released by OBI consortium.
- iii. Open Trading Protocol (OTP): Its purpose is to standardize a variety of payments related activities including purchase agreements, receipts for purchases and payments. A group of companies AT&T, Cyber cash, Hitachi, IBM, Oracle, Sun Micro Systems, and British Telecom created OTP as a computing standard.
- iv. **Open Profiling Standard (OPS):** A standard backed by Microsoft and Firefly. With the help of OPS, users can create a personal profile of preferences and interests that they want to share with business houses. By using this standard, consumers can protect their privacy and also provide marketing information.
- v. Secure Socket Layer (SSL): It is a protocol which is designed to create a secure connection to the server. SSL uses public key encryption to safeguard the data as it travels over the wireless network of the Internet.
- vi. Secure Electronic Transactions (SET): The credit card numbers stored on the servers of business houses are encoded by SET. VISA and MASTER CARD were the pioneers in creating this standard.
- vii. **Trustee:** It is a partnership of companies whose main agenda is to develop public confidence in E-Commerce by giving its seal of approval to those websites which do not share confidential or private information of the consumers with third parties.

## 6. ELECTORONIC BUSINESS

Electronic business (E-business) can be considered as any process conducted by a business organization by utilizing a computer arbitrated network. This form of business relies on automated information system and is conducted with the help of web based technologies. The term "E-business" was first coined Lou Gerstner, CEO of IBM. Adoption of E-business helps a company to join together its internal and external data processing systems in an efficient and flexible manner so that it can work in close cooperation with its suppliers and partners and thus satisfy the needs and expectations of its customers in a better way compared to its competitors. E-commerce is a subset of E-business and it involves the application of knowledge management systems. The range of E-business covers the whole of the business value chain: electronic purchasing and supply chain management, processing orders electronically, handling customer service, and cooperating with business partners. Technical standards enable the companies to exchange data in E-business.

Business organizations may include not-for profit, for-profit and government organizations. The processes include management focused, production, customer centric or production oriented. Examples of E-business processes may relate to the following:

- Production: This may be in the form of ordering raw materials, procurement procedures, automated stock replenishment leading to demand-driven inventory, processing of payments and other electronic links with suppliers, customers and government.
- Customer focused processes: These include selling of goods and services electronically, marketing, receiving and processing customer orders and requests and management and support for customers.
- Management related processes: These include services to the employees, recruiting, training, sharing business information internally, and video conferencing.

# 6.1 E-Business Model

E-business methods would allow companies to wire their internal and external data processing systems in an efficient, flexible and technologically innovative manner. This would facilitate close relationships with suppliers and customers thereby increasing the level of mutual satisfaction and volume of business transactions over a shorter duration of time. In practical terms, the scope of E-business is much wider than that of E-commerce. In other words, E-commerce is a subset of E-business because E-business is a strategic in its focus while E-commerce is mainly concerned with revenue addition by means of WWW or the Internet. Most of the time, E-commerce involves the application of knowledge management systems.

Following are the components of an E-business model:

- i. A business infrastructure which is shared and digitized consisting digital production and distribution technologies such as broadband/wireless networks, content creation technologies and information management systems that will facilitate participation of businesses to generate and make use of economies of scale.
- ii. A highly developed technologically superior operations model that can integrate both supply and buying chains.
- iii. A management model dedicated to E-business consists business teams and partnerships.
- iv. Business policies that are compatible with laws of E-commerce, telecommuting/ virtual office, distance learning, incentive schemes and others.

E-business takes into account the business processes covering the entire value chain which includes electronic purchasing and supply chain management, electronic processing of orders, customer service through electronic devices and cooperation with business partners. There is also an exchange of business data between the companies by means of special electronic standards. The software solutions used in E-business integrate intra and inter-firm business processes. E-business is possible through the use of Web, the Internet, intranets, extranets or combining some of these.

# 6.2 Characteristics and Applications of E-Business

The characteristics of E-business are as follows:

- i. **Customer is King:** Customers have more choices since they can collect information on a range of competing products.
- ii. **Entry Barriers are Low:** Entry barriers are low since the online model can be easily replicated by competitors at a lower cost. Although, conducting business online is relatively easy, digitizing the entire value chain and reaping the benefits of doing so is a difficult task.
- iii. **E-Business Leads to Disinter-mediation:** In e-business, middlemen are replaced by infomediaries. Infomediaries offer information on products and services on behalf of the manufacturers. They link manufacturers and customers.
- iv. Economies of Scale: Since the fixed cost incurred on servicing customers comes down with the increase in the number of customers, organizations have to look for ways to attract more customers to their website. When the number of transactions increases, organizations can obtain economies of scale.

Organizations use e-business for a number of reasons. Some of these reasons are discussed below:

- i. **Transaction Management:** It is possible to completely integrate customers and suppliers using e-business, thus bringing down the transaction costs of purchasing. E-Business also does away with the problems associated with time and distance.
- ii. **Business Efficiency:** E-Business appeals to companies because of its ability to achieve efficiencies in production and distribution. Efficiency can be increased in the entire value chain, right from the procurement of goods to customer service.
- iii. **Reshaping Customer Relationship:** The collection of data through the Internet helps organizations provide better customer service. It also helps in targeting right customers for their products and services.
- iv. **Reaching New Markets and Segments:** Internet makes it possible for companies to explore new markets by providing global reach. Foreign markets can be explored without a physical presence in the market. Moreover, time difference does not pose a hindrance to the study of those markets.

# 6.3 Traditional Business versus E-Business

Traditional or brick-and-mortar businesses were product-centric, with companies competing on the basis of product differentiation and innovation. But in the E-business era, companies focus on customers and adopt a customer-centric approach. In the traditional business, companies manufactured products and customers purchased them. But now customers are a part of product design and they dictate terms to manufacturers with regard to the features of products. Proctor & Gamble (P&G) has created the "P&G Advisors" program to collaborate with customers in developing new products. Customers try new products and provide feedback, allowing P&G to refine products and marketing plans. Before using the

Internet, P&G spent US\$25,000 to test each product concept and took two months to complete a test. Now, P&G can do the same test at a cost of US\$2,500 and obtain results in two weeks. P&G is also using the Internet to take these new products to market. For example, when launching its Physique range of hair care products, P&G invited consumers to register on its Physique.com website to sample the new products. Within 12 weeks, more than five million consumers visited the site.

Information is essential for conducting e-business. Thus information capture, storage and dissemination are important activities in organizations that have adopted e-business. The volume of data that is collected and analyzed is substantial in e-business. Although data was available, even before the Internet age, organizations could not analyze and cleanse the data to get meaningful information. But now modem technology has made real time information processing possible. This has improved the productivity and efficiency of organizations, and enabled them to offer high quality customer service. Traditional business operations are confined to limited geographic locations, but in the case of e-business, operations can take place across the globe due to the ubiquitous nature of the Internet. In addition, automation has made e-business processes and operations more efficient than those of traditional businesses. Transactions that were earlier time consuming are now performed within minutes because customers can interact with the organization either through the fax, telephone, e-mail, or web.

# 6.4 Organizational Culture for E-Business

In E-business, organizations need to continuously make efforts to enhance and leverage their business processes and technology to achieve the highest degree of customer satisfaction. Organizational culture plays an important role in maintaining this focus. The principles that must be followed to develop an organizational culture, which is conducive for conducting e-business are discussed below:

- i. **Ensure Commitment of Top Management:** Employees will not understand the importance of e-business unless top management emphasizes it. The top management should lead all e-business initiatives. Their support is essential for changing the organizational culture and sustaining the change brought about by e-business.
- ii. Create Incentives that Support E-Business Goals: One of the goals of an E-business strategy is to achieve maximum customer satisfaction that should finally lead to customer retention. An organization should design rewards and incentives that align with the e-business goals. Customer satisfaction should be the top priority in the organization. The sales force should emphasize customer retention instead of just focusing on customer acquisition. This may require revamping of the incentive schemes to suit the multi-channel strategy. For example, to encourage the use of the lowest cost channel, Cisco gives incentives to its employees on the basis of orders received through the web and call centers.
- iii. Develop and Maintain a Bias for Action: Short customer life cycles and the rapid pace of business growth make speed and agility key factors in the e-business environment. For fulfilling customer's demand of wider choice of products, superior quality service, and faster product delivery, businesses need to be highly agile. The four factors that will ensure e-business agility are discussed below:
  - Avoid Lengthy Analysis: Organizations tend to spend a lot of time analyzing the market and their competitors. Time is a crucial factor in ebusiness. Spending more time on analysis gives competitors the opportunity to move ahead. So it is essential that organizations complete their analysis within a short span of time.

- Flatten the Hierarchy: The lower the number of hierarchical levels that communication passes through, the more accurate and more effective it is. Hence, organizations should review the number of hierarchical levels present and reduce them to the minimum.
- **Expect Occasional Sub-optimal Results:** Organizations are not always able to achieve their set targets. They may sometimes fall short of their targets. Such failure should be tolerated and regarded as a learning opportunity.
- **Test Everything and Test all the Time:** One of the primary goals of organizations is to build capabilities that will help them understand better its customers, marketplace, and business processes. To achieve this goal, organizations must regularly test new approaches in marketing, sales, and service. Thus, controlled experimentation is a part of an effective e-business strategy.

## 7. ANALYZING BUSINESS PROCESSES FOR AN ENTERPRISE

A process is an orderly series of actions whose aim is to achieve a goal or an objective. In a process, a series of actions take place in a continuous manner in a well-defined path. A business organization performs a number of tasks which are necessary to fulfill its mission and objectives. A business process can be considered to be a collection of interrelated tasks that are necessary to accomplish organizational goals. Business processes are organized keeping in mind the needs of the customers and their goal is to satisfy those needs to the fullest possible extent. A business process can be broken down into a number of sub-processes which have their own characteristics. Their ultimate aim is to achieve organizational goal.

The need for having business processes is value-addition to the customer. They should therefore include only those activities which are geared towards the customer needs and satisfaction and also increased effectiveness and efficiency.

In businesses one comes across three types of business processes:

- i. **Management Processes:** Management is responsible for governing the operations of a system.
- ii. **Operational Processes:** These are the processes that form the core business and create the fundamental value system. The examples of operational processes include sales, marketing, purchasing, manufacturing etc.
- iii. **Supporting Processes:** These processes, as the name indicates, lend assistance to the core processes. Examples of these processes include accounting, recruitment, IT support etc.

Business processes should give importance to the way work is performed in an organization rather than on the features of the product. A process has an orderly sequence of work activities based on the available time and space with a definite starting and ending point. Between the start and end points, there are inputs taken and outputs produced and a sequence of action to convert input into outputs. It should be remembered that the guiding point is the customer around whom the process is built. Business processes are important for an organization because they generate products and services which bring in revenue and profits for an organization. There is an element of cost that is associated with these processes.

The processes can cover many functional areas of the business. The primary processes are those which produce goods and services for the external customer of an organization. Other than primary processes, there are other processes that are essential for the effective management of the business even though they are not physically visible to the external customer.

Based on our discussion about business processes we can summarize its chief characteristics.

Following are the characteristics of a business process:

- i. **Definability:** A process must have an input, an output and its boundaries must be defined in a clear manner.
- ii. **Order:** The activities constituting a process must be in an order, based on their position in time and space.
- iii. **Customer:** Since the process produces an output, that output must be received by a recipient, known as customer.
- iv. Value Addition: A process converts input into output through a series of ordered activities. This conversion must add value to the inputs which should be reflected in the output given to the customer.
- v. **Process Embedded in the Organizational Structure:** A process does not exist in itself as an independent entity. It must be embedded in the structure of the organization.
- vi. **Cross-functional Process:** Many a times a single process covers different functional areas of an organization. This may not be true in all cases.
- vii. **Owner of the Process:** Lastly, the person who is responsible for the performance and continuous improvement of the process also has an important place.

# 7.1 Business Process Management (BPM)

Earlier, we discussed the importance of business processes. Hence it is essential to manage business processes so as to bring in line the organization, and the wants and needs of the customers in an effective manner. The aim of Business Process Management (BPM) is to bring about innovation, flexibility and integration of business with technology. It tries to improve processes on a continuous basis by means of measuring the improvement in processes over a period of time.

## 7.1.1 BUSINESS PROCESS MANAGEMENT LIFE-CYCLE

BPM activities can be divided into five categories. They are: design, modeling, execution, monitoring and optimization.

- i. **Design:** There are two activities undertaken under design. One is the identification of existing process and the second one is the preparation of a blueprint of the proposed process. In the new proposed process, the points that need to be given attention are: the flow of process, the participants in it, alerts and notifications, standard operating procedures, agreements related to services and tasks that need to be carried out.
- ii. **Modeling:** On a theoretical basis, modeling brings in various variables such as the changes in the cost of materials that may have an impact on the way the process is operated under various situations.
- iii. Execution: The execution of a process can be carried out by means of software and human resources. However, the steps of execution need to be documented for further analysis. Software have been developed which shows the complete execution of the processes by means of a computer system. Based on the needs, the application in the software can be added or deleted.
- iv. **Monitoring:** As the name suggests, monitoring involves the observation of the progress of each process so that performance can be gauged. This performance report can be used to work with the suppliers and customers to improve the processes.
- v. Optimization: In optimization, one considers the information relating to performance of the processes that is obtained during the monitoring phase so as to identify the weaknesses in the processes, scope of saving costs or other improvements that can be done in the design of the process.

#### SUMMARY

- Information systems play three vital roles in any type of organization. They support business operations, guide managerial decision-making, and provide strategic and competitive advantage to the organization. Depending on their use in a business, information systems can be classified as Transaction Processing Systems (TPS), Management Information Systems (MIS), Decision Support Systems (DSS), Executive Information Systems (EIS) and Artificial Intelligence (AI).
- Many companies today are in the process of becoming internetworked global enterprises. Businesses are venturing into global markets for their products and services, using global production facilities to manufacture or assemble products, raise money in global capital markets and form alliances with global partners.
- Global companies operate in a competitive environment in which internetworked computer systems make possible the creation of a virtual global market that can instantly and cheaply process business transactions.
- An Information System (IS) is one that accepts data resources as input, processes them and provides output in the form of information products. An information system consists of people resources (end-users and IS specialists), hardware resources (machines and media), software (programs and procedures), data (data and knowledge bases), and networks (communications media and network support) which perform input, processing, output, storage, and control activities and convert data resources into information products
- Internet is an international network connecting large number of computer networks around the world. The Internet has become an important platform for a rapidly expanding list of information and entertainment services and business applications, including enterprise collaboration and electronic commerce systems. The applications of Internet are World Wide Web, E-Mail, Usenet, Internet Relay Chat, File Transfer Protocol, Telnet, etc.
- An intranet is a private network that is present within an enterprise. It is basically a private version of Internet. It is designed to meet the internal information needs of the employees. The information that is related to the intranet are recent corporate news, general product information, details of health insurance, travel expense forms, prices of the products, in house training programs, etc.
- An extranet is a private network that uses Internet technology and the public telecommunication system to share part of a business's information or operations with suppliers, vendors, partners, customers, or other businesses in a secured environment. Extranet provides information which satisfies the needs of customers regarding detailed product description, frequently asked questions about different products, office maintenance information, warranties and customer service/sales.
- The marketing department is a link between the company and its customers. Based on the inputs obtained from the marketing department, the production department designs the products and the finance department allocates resources for the development of particular products. The different features of marketing information system are interactive marketing, sale force automation, sales and product management, advertising and promotion, targeted marketing, market research and forecasting, etc.

- A manufacturing information system is defined as a system that supports the manufacturing functions of purchasing, receiving, quality control, inventory management, material requirements planning, capacity planning, production scheduling, and plant design.
- Computer Integrated Manufacturing (CIM) includes Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM), Computer-Aided Process Planning (CAPP), computer numerical control machine tools, Direct Numerical Control Machine Tools (DNC), Flexible Machining Systems (FMS), Automated Storage and Retrieval Systems (ASRS), automated guided vehicles (AGV), etc.
- Accounting information is a computer-based system that records and reports such transactions and other economic events. It is based on double-entry book-keeping concept and other accounting concepts like responsibility accounting and activity-based costing.
- Financial information system collects data relating to the financial activities in an organization and processes this data to bring out that information which is useful for making decisions in the area of finance. It is integrated with other functional systems in the organization which helps in sharing of data, decision-making and allocation of financial resources.
- The different categories of financial information system are: cash management, online investment management, capital budgeting, financial forecasting and planning, investment management systems, etc.
- Transaction processing systems are the information systems which record the transactions carried out by the company. A transaction is defined as an exchange between two or more business entities.
- The different steps for processing a transaction are data entry, data validation, data processing and revalidation, data storage, output generation, and query support. Transaction processing methods are Batch processing and Real time processing.
- The tasks that can be carried out by the HRM are staffing the organization, training and development, compensation analysis, governmental reporting, etc. The design of Human Resource Management Information Systems for any organization depends on a number of factors. Before designing the system, the organization has to identify the information requirements. It should decide as to what decisions it is going to make about individuals or group of employees.
- An organization is a group of large number of individuals who have a well-defined set of relationship related to authority. They have come together to achieve a set of common goals. The major subsystems of an organization are the departments, programs, teams, divisions etc.
- A business process can be considered to be a collection of interrelated tasks that are necessary to accomplish organizational goals.
- Business process re-engineering refers to radically changing the design of business processes to improve performance and efficiency. It is concerned with redesigning business processes on a large scale. It is applied to strategic business processes.

- In E-Commerce, most of the business transactions are executed electronically between parties such as companies (business-to-business), companies and consumers (business-to-consumer), business and public sector, and consumers and the public sector. The use of telecommunications networks, computers, World Wide Web (WWW), Internet and Intranet and other information technology systems have helped E-Commerce as the preferred way to carry out business transactions.
- E-business helps a company to join together its internal and external data processing systems in an efficient and flexible manner so that it can work in close cooperation with its suppliers and partners and thus satisfy the needs and expectations of its customers in a better way compared to its competitors. E-commerce is a subset of E-business and it involves the application of knowledge management systems.

# <u>Chapter II</u> Management and Systems

# After reading this chapter, you will be conversant with:

- Role of Management Information Systems
- Organizational Theory and the Systems Approach
- Role of a Manager
- Database Management
- Information Systems for Decision-Making

In today's technology driven environment, organizations have grown in size and complexity. Some business organizations known as multinational companies which do business in several countries of the world have varied interests in different sectors of the economy. They have to deal with customers, governments, vendors, employees, suppliers and competitors from different geographical locations. Such business organizations have their headquarters located in a particular city of a country, but they have a number of subsidiaries and branches in different countries. Their organizational structure is very complex. The top management team with its headquarters in a particular country has to take stock of its various businesses scattered around the globe, the strength and weaknesses of its own organization and of its competitors, different products and services it offers and the business opportunities that come up due to changes in business environment and lifestyles of the people.

Thus, information plays a vital role for the management in carrying out the management functions - planning, organizing, control, staffing and decisionmaking. Just as oxygen is important for the survival of human beings but its importance was largely ignored, in a similar way the importance of information was largely ignored by the organizations which were only content with routine and repetitive work. Information provided to the organizations was collected from commonly known sources like data processing applications. There was no means to analyze the available data in a scientific manner. Decisions taken were not based on decision models and simulation techniques but were subjective in nature. But the growth of science and technology, industrial development, the process of liberalization and globalization and the process of economic reforms sweeping many countries has led to the mushrooming growth in number of products and industries. The world has become a global village and the artificial barriers of tariffs and quotas are slowly disappearing. For the business organizations, the entire world is the global market. Unless they are armed with sophisticated information resources which provide planning and decision-making capability, they cannot do business in the international markets.

## **1. ROLE OF MANAGEMENT INFORMATION SYSTEMS**

Management Information Systems (MIS) existed in the organizations from ancient times. In ancient times, information was being provided to the organizations in a number of ways. For instance, military and police organizations had their own intelligence departments with spies providing information. Merchants and businessmen had their stewards who used to provide accounting information. Kings had religious leaders who used to provide information regarding festivals, auspicious days and time. However, the advent of computers has provided a big boost to the organizations in storing, updating and retrieving information on a very large scale. Managers can satisfy their queries by retrieving data from databases and data warehouse with the help of computer-based query languages and application programs. Mathematical models provide a glimpse of the future events based on the given input variables. In addition, computers can process numerical data and perform calculations at very high speeds. In addition to computers, Internet, Electronic Data Interchange (EDI), printers, scanners, application software etc., have increased the scope and reliability of MIS.

MIS is a term which refers to a computer-based system that provides managers with the tools for organizing, evaluating and efficiently running their departments. MIS evaluates data and provides information which can be used to predict past and present trends. These trends provide clues to the managers on the decisions to be taken in future. MIS includes software for making decisions, databases for handling large amount of data which is processed to generate information, decision support systems, skilled personnel and project management applications and other computerized processes. A general definition of MIS is as follows: A Management Information System is an integrated man-machine system that provides information to support the planning and control functions of managers in an organization. Following points may be noted in relation to the given definition:

- i. The output that results from an MIS is the information that helps only that person who is performing the managerial duties. In an organization, there are a number of people working in non-managerial cadres. There are systems that provide information to such people. Such systems do not form a part of MIS. For example, there are systems which generate a lot of information which is routine in nature and which is required by law enforcement agencies. There are some scientific and engineering systems like Computer-Aided Design (CAD) systems and Computer-Aided Manufacturing (CAM) systems which are not included in the definition of MIS.
- ii. Under Management Information Systems (MIS), information is systematically and routinely colleted keeping in mind a well-defined set of rules. MIS is part of formal information network in an organization. The information collected/generated in some peculiar situations and information collected in an informal way or information collected in a systematic way but not on a regular basis does not come under the ambit of MIS.
- iii. MIS provides information which is helpful for managers in planning and control decisions. Success in the various tasks and operation being performed can be achieved by good planning. Planning also incorporates a number of tasks to be performed and the time limit to be set for these tasks. For example, in a car manufacturing company, managers have to decide which components are to be manufactured in their factory premises and which components they have to outsource. They also have to plan for the number of cars to be manufactured for the domestic and international markets. The managers also need to make decisions to control the operations and revise planning process if the circumstances thus warrant. For example, the government may increase tax incentives for exporters and at the same time impose customs duties on imported components. In such circumstances, the managers need to replace imported components with indigenous components and undertake the production of cars for international markets.

In a nutshell, it can be said that, a MIS is a system which:

- i. Subserves managerial functions.
- ii. Collects information systematically and routinely.
- iii. Supports planning and control decisions.
- iv. Includes inputs from raw data that supports the decision-making function of the management.

# 1.1 Definitions of MIS

Many definitions of MIS exist based on the adoptability of a system to the management. Some popular and well-known definitions are as follows:

- i. **Definition as given by Canith:** "MIS is an approach that visualizes the business organization as a single entity composed of various inter-related and interdependent subsystems looking together to provide timely and accurate information for management decisions-making, which leads to the optimization of overall enterprise goals."
- ii. Definition as given by Dicky: "MIS is an approach to information system design that conceives the business enterprise as an entity composed of interdependent system and subsystems, which with the use of automated data processing systems, attempts to provide timely and accurate management information which will permit optimum management decision-making."

- iii. **Definition as given by Schwartz:** "MIS is a system of people, equipment procedures, documents and communications that collects, validates, operates on transformers, stores, retrieves, and presents data for use in planning, budgeting, accounting, controlling and other manager process."
- iv. Definition as given by George M Scott: "Management Information System is comprehensive, coordinated information subsystems which are rationally integrated and which transform data into information in a variety of ways to enhance productivity in conformance with manager styles and characteristics on the basis of established criteria."
- v. **Definition as given by Frederick B Cornish:** "A proper Management Information System is "structured to provide the information needed when needed and where needed." Further, the system "represents the internal communications network of the business providing the necessary intelligence to plan, execute and control."

MIS is a term that refers to a computer-based system providing managers with tools for organizing, evaluating and running efficiently their departments. MIS evaluates raw data and provides information that can be used to predict past and present trends. These trends provide clues to the managers for decision-making in the future. MIS includes software for making decisions, databases for handling large amount of data that is processed to generate information, decision support systems, people management and project management applications and other computerized processes.

# **1.2 Elements of MIS**

Management Information System consists of three different terms. We shall describe each one of them in detail.

- i. **Management:** Mary Follett defined management as: "The art of getting things done through people." It is a set of functions and processes designed to initiate and coordinate group efforts in an organized setting, directed towards promoting certain interests, preserving certain values and pursuing certain goals. However, the term management has been defined in various ways by different authors. Management can be defined as a group of individuals who make decisions about how a business is run. The personnel constituting the management team have the responsibility to run the general administration of the company, formulate policies and programs and work towards achieving the goals and objectives of the business. They also have to safeguard the interests of the owners of the business and maximize their wealth. The key responsibilities of management are: (i) planning, (ii) organizing, (iii) motivating, and (iv) controlling.
- ii. **Information:** The data is processed to obtain information. For an organization, information is one of the resources like money, materials, men, machines, methods, markets and management. Information is significant to the manager for planning operations and taking decisions in order to discharge his responsibility. The type of information which a manager requires has to be identified and only that data should be collected from which the required information can be generated. Information resources are in the form of stored data (i.e., data warehouse and databases) which can be used many times to generate different kinds of information.

For managers, information relevant to their domain of duties or responsibilities is important. For example, a finance manager is interested only in information related to finance and accounting, whereas the information related to advertising means, customer profile or market share has no relevance to him. Thus, MIS should be geared to accumulate raw data from various sources, process that data and supply the information at the right time and in right format so as to satisfy the information needs of various departments like marketing, finance, production, etc. iii. System: A system is an organized or complex whole. It is a conceptual or physical entity that consists of interdependent parts or components. It is this interdependency which is a characteristic of the parts of the system. System concept provides a useful framework for describing and understanding the processes in an organization to develop solutions to the problems. System's approach takes a holistic view of the problem by taking into account the entire organization as a single entity. As discussed earlier, MIS collects information in a systematic way with well-defined procedures. Information system involves hardware, software, people, methods, procedures and applications that are dependent on one another for successful functioning of the Information System (IS) department. This department harmonizes the needs of all other departments and provides a communication link between them such that there is no delay in the availability of information.

## 1.3 Relationship of MIS with other Disciplines

There are four major disciplines with which MIS can be linked. They are: (i) Management Accounting, (ii) Management Science/Operational Research, (iii) Management and Organization Theory, and (iv) Computer Science.

#### **1.3.1 MANAGEMENT ACCOUNTING**

The accounting field consists of two major areas. They are financial accounting and management accounting. Financial accounting measures the income for a specific period of time usually one financial year and also reports financial status at the end of the period. The accounting statement which measures the income for a specific period of time is known as the income statement while the accounting statement which specifies the financial position of the concern in terms of assets, liabilities and the owner's contribution as on a particular date (usually the last day of the financial year of the company) is known as balance sheet. The income statement and the balance sheet have limited use for the management but are designed for the investors so that they can make proper investment decisions.

The other area of accounting known as management accounting is designed to help the management in taking relevant financial decisions. It employs the techniques such as capital budgeting, ratio analysis, break-even analysis, transfer pricing etc., for management control and management decision-making. Based on the techniques of management accounting, budgets are prepared and performance of different departments analyzed. The information provided by a management accountant forms a part of MIS and is very useful for managerial decision-making in the field of accounting and finance. The birth of MIS can be attributed to the field of management accounting.

### **1.3.2 MANAGEMENT SCIENCE/OPERATIONAL RESEARCH**

Management problems can be solved with the help of management science and operations research models and techniques. In management science methods, a systematic approach and scientific methods are followed to investigate the problems and arrive at optimal solutions. The techniques of management science find their place in Decision Support System (DSS) which is a part of MIS. This helps in making quantitative and analytical information available to the users of MIS. Management science also utilizes mathematical models to simulate a particular problem. When mathematical models and computer-based solution algorithms are incorporated in DSS, it facilitates building models for future plans and activities. A user can know the outcome of the event by providing sample inputs to the model and simulating it.

## **1.3.3 MANAGEMENT AND ORGANIZATIONAL THEORY**

An organization is a large group of individuals who have a well-defined setoff authority relations between them. A number of organizations have come into existence in the industrial societies that have an influence on most parts of everyday life. The development of organizations and that of bureaucratic tendencies have a close relationship. Organizations have developed tremendously

in size in the twentieth century and are found in both public and private sectors. Organizations come into existence to achieve particular purpose.

MIS provides invaluable support for the organizations by coordinating the activities of different departments and helps managers in carrying out the organizational functions. The concepts and philosophies inherent in the field of management and organization theory hold the key to understand the functions of MIS. Some of these concepts are:

- i. Behavioral theory of organizational and individual decision-making,
- ii Individual motivation,
- iii. Group processes and group decision-making,
- iv. Leadership techniques,
- v. Organizational change process, and
- vi. Organizational structure and design.

## **1.3.4 COMPUTER SCIENCE**

Before the advent of computers, the processing of data to generate information was done manually. Industrialization has increased the size of economy of both the developed and developing countries. International business activities have grown many times since the end of World War II. Therefore, organizations have to transact with a large amount of data and carryout innumerable numerical calculations that deal with accounting, financial and banking data. With the help of computers, organizations can perform routine and repetitive calculations involving large amount of data within a short period of time. Thus, computers have entered the field of MIS. Marketing, finance, production, accounting and human resource departments have benefited due to the introduction of computers. Different algorithms and application programs have been developed for various functions of the organizations to access, update, insert and delete data and produce required information. Storage devices have the capacity to store large amount of raw data.

# 1.4 Characteristics of MIS

The following are the main characteristics of MIS:

- i. **Comprehensiveness:** MIS is comprehensive in nature since it provides detailed information on a number of issues. MIS contains information which is designed to serve the information needs of the managers at all levels. The other information systems included in the purview of MIS are formal and informal systems, computer and manual systems, project information systems, office information systems, decision support systems, executive information systems and other computer and mathematical models. It also includes Transaction Processing System.
- ii. **Co-ordination:** MIS is centralized and the co-ordination work is carried out by MIS department. Data processing, office automation, intelligence, decision support system and other components are planned, developed, coordinated and executed in an integrated manner. This ensures that the information is sent and received by all subsystems, information queries of the managers are met without delay and information system operates in an efficient manner.
- iii. **Subsystem:** MIS consists of a number of subsystems which are put together. Thus, it is a unified system. The activities of each of the subsystems are well-defined and they all share the common goals which are to be achieved by MIS. Each subsystem may have a single or multiple activities.
- iv. **Integration:** Different subsystems are integrated and their activities are inter-related. To achieve integration, there is a facility wherein each subsystem receives (sends) data from (to) other subsystems. Integration helps

in efficient processing of information, which in turn reduces multiple sources and intermediate processing of the same data. Due to data integration, the top-level managerial teams who have to continuously monitor external environment and markets can retrieve data, regardless of the functionality. Thus, little time is spent in accessing the timely, relevant and accurate data.

- v. **Transformation of Data into Information:** There are a number of different methods in which MIS can transform the data into information. For example, the sales data can be processed to achieve information regarding domestic and international sales. Computers and the field of IT can help in presenting the information in the required format. For example, data can be presented in tabular, graphical or in text form. In addition, complex mathematical and statistical operations can be performed on the raw numerical figures to arrive at meaningful information. Statistical, accounting and business packages are available for this purpose.
- vi. Enhancement of Productivity: The organizations which adopt MIS to satisfy their need for systematic, accurate and timely information, also enjoy the benefit of enhanced productivity. The productivity is enhanced because MIS can simplify large amount of complex data and produce information. The data is collected from various internal and external sources. The information helps managers in predicting future business environment. SWOT (Strength, Weakness, Opportunities and Threats) analysis can be carried out before hand to face unusual and inevitable circumstances and also take up the challenges thrown up by the competitors.
- vii. **Compatibility:** MIS is designed and developed based on the unique managerial styles and behavioral pattern of the personnel who use it. The functions, responsibilities, information needs and thinking pattern of the three levels of management (i.e., Top management, Middle management, and Bottom management) are different. MIS takes into account information needs of all the three levels of management. It also facilitates the movement of information among the three levels. This ensures coordination and cooperation in the organization.
- viii. **Relevant Information:** A MIS is installed and implemented based on the information requirements of a particular organization. For instance, the needs of a banking organization are different from that of a garment manufacturing organization. The banking organization is concerned with the interest rate regulations of the Reserve Bank of India, its own loan portfolio, Non-performing assets, retail and corporate customers, etc., whereas a garment manufacturing organization is concerned about the availability of raw materials, imposition of quotas and tariffs by other countries, technological upgradation, export incentives, tax structure etc. Thus, based on the differing information needs, MIS structure is designed by the experts in such a way that only relevant information needed by different organizations based on their business environment is provided by MIS.
- ix. **Quality Criteria:** MIS is designed initially and upgraded periodically so that it meets the quality standards with respect to timeliness, relevance and accuracy of information. The level of tolerance with regard to the deviation from standards is different for different levels in an organization.
- x. **Feedback:** MIS should have a feedback and control mechanism to monitor its effectiveness and efficiency. Since most of the MIS structures are based on computerized environment, the most obvious feedback may be in the form of technical malfunctioning of the computer systems and networks. Feedback may also be in the form of user satisfaction with the system, number of users of the system and their frequency of use, response time of the system, user charges and cost of operating the system. The statistical data relating to the parameters of feedback may help to evolve managerial opinion regarding MIS.

- xi. **Flexibility:** MIS must be designed in such a way that it can be easily modified according to the needs and circumstances of the environment. The organization may grow in size, may increase its product range or may diversify into other businesses, which results in the change in the structure and design of the IS as per the new requirements. Such changed conditions warrant changes in the MIS structure and design so that it can cope up with the new kind of information needs. New experts may also have to be inducted into the MIS department to effect the changes.
- xii. Modularity: MIS should be composed of many modules or subsystems rather than a single entity. Each module can be assigned different functions. For example, one module may be involved in collecting the data while other module may process the data. A third module may be involved in producing the output. Modular structure helps in easily locating the failures of the system.
- xiii. Selective Sharing of Data: MIS provides a definite means for sharing of data. The system is designed such that multiple users can access the same data and information. Modern databases facilitate sharing of data and retrieving of selective information under a protective environment through query languages.

# 1.5 Structure of MIS

The following are the three forms in which the structure of MIS can be described:

#### **1.5.1 FUNCTIONAL FORM**

In an organization, a number of functions are performed like marketing, production, finance, purchasing, technical and accounting. Each function has its own information system which caters to the needs of the managers of that functional area. However, each information system has the right to interface with other systems in order to share information.

# **1.5.2 MIS AT DIFFERENT LEVELS**

Management can be viewed as structured into three hierarchical levels. They are: (a) The top or the strategic level, (b) The middle or the tactical level, and (c) The bottom or the operational level. Thus, MIS caters to the needs of information at all the three levels.

#### The Top Level or the Strategic Level

At this level, MIS is concerned with determining, maintaining and supplying information required by top level management. Top management is involved in strategic decision-making. Examples of strategic decisions are: mergers and acquisitions, new product planning, capital investments, financial structuring, etc. Top management establishes the policies, plans and objectives of the company as well as a budget framework under which various departments operate. They require strategic information about external environment, technological developments and market for products. MIS has to secure such information from various internal and external sources. The plans, policies and objectives formulated at the top level are passed down to middle management where they are translated into specific revenue, cost and profit goals if the departments work under the concept of cost or profit center.

## The Middle Level or the Tactical Level

At this level, MIS is concerned with information that is necessary to elaborate, clarify and operationalize organizational goals formulated by the top level management. Decisions are taken at this level to transform policies and programs into actions. The examples of decisions taken at this level are pricing of products and services, planning of capacity, budget preparation, purchasing contracts etc. Additional information supplied by MIS at this level helps in formulating norms and in translating strategies and policies into action programs.

#### The Bottom or Operational Level

MIS at this level is concerned with providing information to regulate and coordinate the programs and operational plans to produce goods and services. At the operational level, inputs are converted into outputs i.e., goods and services are produced to meet the goals of sales target and profits. Most of the decisions taken at this level are routine and repetitive. The examples of such decisions are production scheduling, maintenance, re-ordering, credit approval, etc. The information at this level is routine and repetitive. The information regarding production schedules generated at this level is sent to the higher levels.

#### **1.5.3 COMPREHENSIVE STRUCTURE OF MIS**

The structure of a MIS is known as comprehensive if it possesses the following characteristics:

- i. It should be closely directed by the management.
- ii. It should integrate various subsystems of the management.
- iii. It should avoid duplication and redundancy of data.
- iv. It should provide for the effective dissemination of information.
- v. It should be capable of meeting the information requirement of managers working in different functional areas.

# 2. ORGANIZATIONAL THEORY AND THE SYSTEMS APPROACH

Organizational theories have come into being to understand the structure of various organizations, their functions and properties so as to enhance the productivity of goods and services and provide satisfaction to functions and properties so as to enhance the productivity of goods and services and provide satisfaction to the members of the organization. The modern viewpoint is that each organization is unique in nature and hence needs personalized solutions taking into consideration the size, technological requirements, environment within which an organization is working, the characteristics of the industry etc. Organizational theories derive their basis from varied fields of study such as psychology, political science, economics, anthropology and sociology. These theories explain the behavior and dynamics in the context of individual and group (because organizations have groups of individuals). The understanding of organizations and organizational behavior has become increasingly significant due to the cultural diversity of individuals who have come together to work and the need to have interaction at the global level with other organizations. Organizational studies involve the use of data and models.

The decision-making process of the managers is facilitated by the use of MIS. In addition, the functions of planning, control, directing and staffing can be undertaken with the help of MIS. Thus, the knowledge of management and organizational theories help the MIS designers to determine the decisions that managers make and the functions they perform. They can also know the type of data which is required by the managers for making decisions and carrying out functions.

# 2.1 Systems Theory

A system is an organized or complex whole. It is an entity, conceptual or physical which consist of interdependent parts or components. The various parts of the system are interdependent on one other. In a system, there are many processes which have reciprocal cause-effect pathways. A system is made up of subsystems and these subsystems have further subsystems. In a large context, a system is an assembly of procedures, processes, methods, routine techniques etc., united by some form of regulated interaction to form an organized whole. The world outside the system is called the environment. System itself is the subsystem of the

environment. For instance, business system with its different subsystems works within the boundaries of the environment known as society.

The environment has a big impact on the behavior of the system because it places constraints in the form of financial resources, rules and regulations, market conditions etc. Since the system is very small when compared to its environment, its impact on the environment is negligible. All the systems, except the closed system cannot exist in isolation. A system has a feedback and control mechanism. This is essential for the system to achieve its desired goals. The feedback and control mechanism monitor the output. If the system is producing output beyond the desirable range then the feedback control mechanism signals for corrective action to be taken to bring the output back in the desired range.

The examples of systems are educational system, computer system, solar system, economic system, communication system, accounting system, etc. In the past, the problems facing an organization where tackled on an individual basis or in isolation, without taking into consideration the entire organization. For instance, the problems facing a particular department were tackled at that level without considering its relationship with other departments. However, the problems facing one department will have its effect on other departments. Today, from the system's point of view, the different parts or departments of an organization are viewed as being interdependent on each other such that the goals of all the departments are harmonized to achieve the common objective for which the organization has come into being. For instance, a college system consists of the buildings, faculty, administrators and a library that work in harmony with the sole purpose of providing education to the students. If any one part of the system, for instance, faculty do not function properly then it will have its negative effect on the entire organization.

System can be abstract or physical. An abstract system as the name signifies has no tangible existence. It is only an orderly arrangement of interdependent ideas or constructs. For example, theology system consists of ideas about God and the relationship of humans with God. In contrast, a physical system is a set of elements which operate together to accomplish an objective. Examples of physical systems are circulatory system, transportation system, weapons system, etc.

## 2.1.1 DEFINITION OF SYSTEM

A system can be defined as an assembly of different parts where:

- i. The parts or components are connected together in an organized manner.
- ii. The parts or components are affected by being in the system (and are changed by leaving it).
- iii. The assembly exists to achieve a purpose.
- iv. The assembly has been identified by a person as being of special interest.

## 2.1.2 CHARACTERISTICS OF SYSTEMS

- i. A system is in existence to achieve some purpose.
- ii. The five components of a system are input, processes, output, feedback and control.
- iii. Systems are made up of subsystems or inter-related parts whose goals are known as subgoals. The system can only be explained by considering it in totality. This is known as holism or synergy. Synergy states that any whole is more valuable or useful than the sum of its individual parts. When the appropriate parts are combined, some properties appear from the whole which the parts do not possess in isolation. The properties which emerge in this way are known as emergent properties.
- iv. Systems are hierarchical which imply that the parts of subsystems are made up of other smaller parts. For instance, an accounting system is a subsystem

of information system and information system is itself a subsystem of the planning system. Also, the planning system is a subsystem of the organization as a whole.

- v. When one part of the system is altered, then this will have its effect on the other parts of the system. For instance, a change in the departmental procedure of one department will affect other departments in the organization.
- vi. Different subsystems work in such a way that the goals of the system are achieved. Thus, the goals of the system are preferred over the sub-goals of the subsystems. Where subsystems do pursue their own objectives to the determinant of higher objectives, then a condition of sub-optimality is said to exist and the designers seek to avoid sub-optimality wherever possible.
- vii. Subsystems have to work in a coordinated way with other subsystems even though they are in pursuit of their individual sub-goals.
- viii. A harmonious relationship among the subsystems is essential to achieve the overall goals of the system.

# 2.1.3 THE SYSTEM BOUNDARY

The boundary of a system defines the limits of a system and distinguishes it from every other thing including the environment. The system boundary and the interface between subsystems is shown in the figure 1. For example, college is a system where the inputs to this system are students, professors, administrators, textbooks, equipments etc. In this system, the activity which is carried out known as processing, is teaching and educating the students, carrying out research activities etc. The output of this system is the students who have acquired knowledge and meaningful research for the betterment of the society. The main purpose or goal of this system is to gain and enhance knowledge in different faculties. Thus, this system is dedicated to the cause of education and knowledge. Thus, it will not cross the boundary of the education field. For instance, it will not enter or take up work related to other system like manufacturing, etc. Thus, all things outside the system are considered environment.



Figure 1: (a) Boundary of the System (b) Interface between Subsystems

#### 2.1.4 THE ENVIRONMENT OF SYSTEMS

All the elements which are outside the boundary of the system or the elements not within the system constitute the environment of the system. In other words, environment can be defined as those external elements which can affect the state of the system whenever there is a change in their own attitudes, behavior or properties. Also any change in the behavior of the system also affects those external elements. Most of the time, the external environment is dynamic and rarely static. Some factors of the environment have a profound effect on the

system while others do have temporary effect. Many times it is not possible for the organization to keep itself immune from the factors of the environment. Figure 2 shows the environment for an organization.



Figure 2: The Environment of an Organization

# 2.1.5 DIFFERENT TYPES OF SYSTEMS

The following are the different types of systems:

Open and Closed Systems: An open system is one which interacts with its i. environment and is shown in the figure 3. It has a feedback mechanism. It receives inputs and is influenced by the environment, supplies output to the environment and in turn influences it. All social organizations are open systems. Example of an open system is the business organization. In a business system, there is a free flow of information among the subsystems and the environment. The success and survival of the business organization depends on the way it adapts to changes in the environment. In an open system, feedback from the system forms the input to the control unit. After processing the feedback, control unit identifies the course of action to be taken. In processing the feedback, control unit verifies whether all the rules, guidelines, principles are correctly followed. If they are violated then a difference emerges between the actual performance and the desired performance. Control unit suggests measures to the system to minimize or eliminate the difference between actual and desired performance. Control may be tangible or intangible, qualitative or quantitative, explicit or implicit, simple or complex, written or oral and formal or informal.

A closed system is one that is isolated from its environment as shown in the figure 4. These systems are self-sufficient such that neither the external environment has an influence on their behavior nor the system has any

#### Management and Systems

influence on the external environment. Thus, a closed system does not receive any feedback. It does not receive or process any input from the external environment. Closed systems are very few in the world. Example of a closed system is the production subsystem of an organization where arrangements are usually made to limit exchanges with external environment so that operations in the subsystem are not influenced by the changes in the external environment.

Figure 3: Open System







- ii. **Stable and Dynamic Systems:** A stable system is one which experiences very little change over time. On the other hand, a dynamic system undergoes rapid and constant change with time.
- iii. Adaptive and Non-adaptive Systems: A system which changes its response due to changes in the environment is known as adaptive system, while, a non-adaptive system remains static even though there may be changes in the environment.
- iv. **Permanent and Temporary Systems:** Permanent systems have a very long lifetime. Temporary systems are in existence for a relatively short period of time.
- v. **Deterministic Systems:** These are predictable systems where the output can be predicted based on the input and type of process. The examples of such systems are: a computer program, machines, etc.
- vi. **Probabilistic or Stochastic Systems:** In these systems, some conditions of the system can be predicted from the previous state but only in terms of probable behavior and hence there is always a certain degree of error in the prediction. For example, based on the sales trends, the stock of raw materials required for the inventory can be predicted. However, the actual stock of raw materials required may be higher or lower, depending on the seasonal fluctuations.

vii. **Self-Organizing Systems:** Self-organizing systems are those which adapt and react to inputs or stimuli. The method of adaptation is uncertain and the same inputs always do not produce the same responses. Social groups and organizations are examples of these systems.

## 2.1.6 SYSTEM PERFORMANCE AND STANDARDS

A system which is operating in the environment has to generate output because it utilizes the inputs of the society. That system is preferable which is capable of generating output which meets the standards expected by the society. For instance, accounting system should generate financial statements which should conform to the standards set by the law. This is very essential because a system exists in order to serve the interests of a society. Thus, for a system to generate a standard output, its performance should be constantly monitored. The specific objective of the system is known as system performance standard. Thus, different systems in different areas of human activity may have different performance standards set by themselves. For instance, the performance standard for a university may be to produce a certain number of research articles in international journals each year in different faculties. For a marketing organization working for the credit card division of a banking company, the performance standard may be to sell 1,000 credit cards per month in a particular state. However, the actual performance of the system may not match the standard set by itself. The actual target achieved may be higher or lower than the set standard. There are many situations which are responsible for the difference between the actual and set standards for a system. Some external situations that the systems face may be beyond the control of the control mechanism of the system. There are various measures to judge the performance of a system. They are:

- i. Efficiency: It is a measure of the total output generated divided by total input consumed and is expressed as a percentage ranging from 0 to 100 percent. For instance, the efficiency of the motor is the amount of energy produced (in terms of work done) divided by the amount of energy consumed (in terms of electric power). It is not possible to quantify the efficiency of all the systems. For instance, the output of university is the number of educated students and the amount of productive research work, which cannot be quantified in numerical terms. Thus, for service-oriented systems like universities and hospitals the efficiency can be determined only on subjective basis.
- ii. **Effectiveness:** It is the measure of the extent to which a system achieves its goals. It can be computed by dividing the goals actually achieved by the total number of goals planned initially in the beginning. Thus, the result for effectiveness may be obtained in percentages. For instance, before the commencement of the academic year, a professional institution (Business school, engineering college or a medical college) has set the goal of achieving placement for its current batch of 100 students. However, the institution is able to secure placement only for 80 students. Thus, the effectiveness is 80 percent.

#### 2.1.7 SYSTEMS THEORY APPLIED TO BUSINESS

The application of systems approach to business organizations started in the 1960s. To understand the concept of system as applied to a business, let us consider a business organization consisting of several departments. When all the departments are integrated, then the output produced by the organization is more than the sum of the output produced by each department working in isolation. This is known as principle of *synergism*. According to this principle, if there are two departments and the output of each department is two units in isolation then by integrating the two departments, the final output of the organization may be 5 units instead of 4 units. The principle of synergy is commonly known as 2 + 2 = 5.

In another instance, let us consider the sales department and production department of an organization. It is the production department which designs and develops the product. However, the sales department is responsible for selling that

product to the ultimate customers. If the sales and production departments work in isolation then the company cannot increase its market share because the sales department may not get the product to sell from the production department as desired by the customers. The sales department has to collect information regarding the tastes and preferences of the customers and work in consultation with the production department to bring out the product which satisfies the needs and aspirations of the consumers. Thus, both the departments working in coordination can increase the market share of the company. MIS can go a long way to achieve this type of integration and coordination by facilitating the exchange of information between the departments.

In systems theory, each system is composed of a number of subsystems. A proper flow of information would help each subsystem to integrate its functions with the functions of other systems and finally relate all the functions towards the common goal. Business or organizational systems greatly benefit from the basic tenets of the systems theory.

# **3. ROLE OF A MANAGER**

As the name suggests, a manager is a person who manages an organization or business. A manager is an employee in an organization who has the responsibility of planning and directing the work of a group of individuals who are most of the time other employees, supervising their work, and guiding and correcting their work as and when necessary. In the management hierarchy, this is the first step.

In many organizations there are many supervisors who are guided by a manager. The supervisors are in direct contact with the workers. It is necessary for a manager to get himself acquainted with the work of all the groups who work under him even though he may not be an expert in that field. Managing other people is an art which has to be mastered for a person aspiring to be a manager. Many organizations give power to a manager to hire or fire employees. Managers also have the power to transfer or change the work assignment of the employees working in a team.

In order to build an effective organizational system and achieve its goals and objectives, managers need to handle business risks and uncertainties effectively. MIS provides necessary information to the managers to fine-tune and expand their knowledge so that they would be ready to face adverse and uncertain trends in business. A good decision support system should be able to help managers take up effective and timely decisions. The requirement of modern businesses is that the traditional controls be handed over to managerial personnel so that they can handle the tasks efficiently, for which they are responsible for. Moreover, the managers have to keep themselves abreast with the latest developments in the field of technology that can have a profound impact on their business prospects.

# 3.1 General Role of a Manager

The role of a manager is as follows:

- i. **Manager of Outcomes:** It is the manager who is responsible for moving things ahead. The things may be the completion of a project, installation of new computerized system or establishing a new department/manufacturing facility. Under his guidance other employees work. A newly recruited manager has an important role in this regard. Even though a manager does not complete the tasks such as selling a product, producing engineering drawings or the preparation of payrolls, it is the responsibility of the manager to ensure that other people(employees) successfully do these things in an efficient manner. A manager has twin role to play in the sense that he must often undertake complex activity of decision-making all by himself and at the same time manage others and oversee their work.
- ii. **Manager as Coordinator:** It is the responsibility of a manager to coordinate the work of a team in a meaningful manner. The manager must make the

team work as a cohesive unit by clearly defining its activities, make himself aware of their strengths and weaknesses, ensure that the work is progressing without any glitches and there is no redundancy in the work of the team members. The targets or goals given to the individual team members must be harmonized towards an ultimate goal. Harmonizing individual goals with the organizational goal is a difficult task as each team member has his/her own way of working based on their skill, experience and education.

- iii. Manager as Facilitator: In addition to being a coordinator, a manager must also be its facilitator by making available different kinds of resources such as finance, equipment, technology and also people with a variety of skills. Harmony in the team will ensure that team members share skills and knowledge among themselves. Ensuring adequate levels of morale and motivation is also the responsibility of the manager. This can be achieved by encouraging others to contribute without forcing or coercing them.
- iv. **The Manager as Coach:** Managers are responsible to bring to light the inherent skills of the team members so as to make their contribution to the organization more effective. The importance of coaching can be compared to that of teaching someone on a new skill. Managers can coach others in order to remove the obstacles in their way. The examples of such obstacles are:
  - Lack of confidence;
  - Lack of clarity over personal and professional goals; and
  - Confusion over which techniques and approaches to deal with a situation.
- v. **The Manager as Politician:** The job of a manager is political in nature. The political aspect of this job is obscure and disguised. However, the political part in the job of a manager cannot be underestimated for its success. For playing the game of politics, a manager must have good negotiating skills with other stakeholders of the business. Political role also involves improvement in the personal and professional networks because most of the time new jobs and promotions are gained through contacts that have been established long time ago.
- vi. **The Manager as Commander:** A manager can be compared to a commander of an army or a captain of a ship. The command and control aspect of the manager's role that we are talking about has some serious flaws. This is because if the manager keeps all the power and authority with him than the staff exhibits very little initiative and innovation. Every time they have to depend on the managers for directions and this may have its implication on the fast changing nature of the business world. This may also demoralize the employees since they perceive that organization does not have trust in them.
- vii. **Support for Development:** Managers need to develop a list of skills in addition to reflective attitude and knowledge along with an indigenous management style. Such managers are better performers because they have developed good working relationships with others, utilized resources in a better manner and have appreciable contribution to the organization.
- viii. **Management of Time:** A manager has to keep track of the time and attention that is being given to various activities. If a manager performs his duties diligently, then he becomes a role model for others. Time management helps in completing large number of things, reduction of last minute stress and makes available more time for crucial tasks. Successful time management would also help in managing someone else.

ix. **Employee Appraisals:** The challenge before the managers is to evaluate their staff in the form of an appraisal. In this regard, assistance can be sought from the HR representatives to know the process being followed in the organization for carrying out appraisal.

## 3.2 Managers as Decision-Makers

The success of an organization depends greatly on the decisions that managers make. For this reason, managerial approaches to decision-making have been the subject of great interest. In this section, we shall describe two major types of models which describe how managers make decisions.

- Rational Model: The rational model of managerial decision-making has its i. roots in the economic theory of the firm. When theories about the economic behavior of business firms were being developed, there was a general tendency among economists to assume that whatever decisions managers made would always be in the best economic interests of their firms. This assumption was initially accepted by many management theorists. According to the rational model, managers engage in a decision-making process which is totally rational. They have all the relevant information needed to take decisions. They are also aware of different possible alternatives, outcomes and ramifications, and hence make rational decisions. This view which was in vogue during the first half of the twentieth century, has serious flaws, as it is quite difficult to obtain complete information and make "optimal" decisions in complex situations. In spite of its drawbacks, the rational view provides a benchmark against which actual managerial decision-making patterns can be compared.
- ii. Non-rational Model: Unlike the rational view, several non-rational models of managerial decision-making suggest that it is difficult for managers to make optimal decisions due to the limitations of information-gathering and processing. Within the non-rational framework, three major models of decision-making have been identified by researchers. These are: (a) satisficing model, (b) incremental model, and (c) garbage-can model.
  - a. **Satisficing Model:** In the 1950s, an economist, Herbert Simon studied the actual behaviors of managerial decision-makers. On the basis of his studies, Simon propounded the concept of bounded rationality. This concept suggests that the managers may not always be perfectly rational in making decisions. Their decision-making ability may be limited by certain factors like cognitive capacity and time constraints. The concept of bounded rationality was offered as a framework to facilitate better understanding of the actual process of managerial decision-making. According to the concept of bounded rationality, the following factors commonly limit the degree to which managers are perfectly rational in making decisions:
    - Decision-makers may have inadequate information about the nature of the issue to be decided. They may also not possess enough information about possible alternatives and their strengths and weaknesses.
    - The amount of information that can be gathered in regard to a particular decision.
    - Is limited by time and cost factors.
    - Decision-makers may overlook or ignore critical information because of their perceptions about the relative importance of various pieces of data.

- The degree to which decision-makers can determine optimal decisions is limited by the individual's capacity and intelligence.
- The inability to remember large amounts of information is another factor that limits the ability of managers to make rational decisions.

Simon argues that instead of searching for the perfect or ideal decision, managers frequently settle for one that will adequately serve their purpose. He contends that managers accept the first satisfactory decision they uncover, rather than searching till they find the best possible decision. Simon calls this 'satisficing'. The satisfying model holds that managers seek alternatives only until they identify one that looks satisfactory.

- b. **Incremental Model:** Another approach to decision-making is the incremental model. The incremental model states that managers put in the least possible effort only enough to reduce the problem to a tolerable level. The manager here is concerned more with finding a short-term solution to the problem than making a decision that will facilitate the attainment of goals in the long-term. The incremental model does not require managers to process a great deal of information in order to take a decision. In this model, only a small, limited set of alternatives is considered: all options are similar to the existing situation. Objectives are not necessary; the decision-maker decides on an option, considers the consequences, and if reasonable, then moves down that path. If the difficulties subside, the path is continued. If the difficulties persist, then a different option is pursued and the direction changed. This form of trial and error (small incremental changes) is continued until noise subsides.
- c. Garbage-Can Model: The garbage-can approach to decision-making holds that managers behave randomly while making non-programmed decisions. It assumes that organizational objectives emerge spontaneously and they are not set beforehand. Also, means and ends exist independently. That is, decision outcomes are chance occurrences and depend on such factors as the participants involved in the decision-making process, the problems about which they happen to be concerned at the moment, the opportunities they happen to identify and their favorite solutions or the solutions they use the most to solve most problems. The model explains how decisions sometimes occur, but it does not give suggestions for action.

The garbage-can strategy is effective in the following situations: (i) when the managers have no specific goal preferences, (ii) when the means of achieving goals are unclear, and (iii) when there are frequent changes in the participants involved in decision-making. This approach can have serious consequences. The garbage-can approach is often used in the absence of strategic management.

# 3.3 Managerial Considerations in the Adoption of Technology

The following are the considerations which have to be taken into account by the top management team in the technology driven environment.

i. Acceptance of Technology by other Managers and Users: Employees are the most important resource for an organization. Management adopts IT basically to automate the routine and repetitive administrative and business processes. However, a desired and positive change in the attitude of employees regarding the adoption and use of IT has to be brought about for its assimilation in the corporate culture. Otherwise, employee discontent with the new system will hamper the productivity of the organization. Training sessions and enhancement of skills of employees will go a long way in minimizing resistance to change. The technical staff of MIS department have to work with employees of different functional areas to understand their requirements and problems and try to educate them about the benefits of the new system.

- ii. **Processing of Hardware and Software Assets:** Top management has to take decisions regarding the location or place of installation of hardware and software assets of the organization. Many computers are general-purpose machines which are capable of running different applications. Users in the functional departments like manufacturing, finance or marketing may request for their own computer systems and specialized software to carry out their individual tasks. Management has to not only take into account the individual needs of different departments, but also has to devise strategies for coordination of activities of different departments, so as to achieve common objectives of the entire organization. The management also has to consider different alternatives available in the market for IT resources based on the opportunities and constraints. The trend in most of the organizations is towards client-server computing.
- iii. Outsourcing: It involves engaging an external company to manage a part of firm's technological aspects of business applications or functions. For instance, firms can obtain services from external agencies in the field of systems integration for developing a specific application. A firm can outsource a part or whole of its IT requirements. Some of the factors which are responsible for a firm to outsource its IT requirements are:
  - a. Outsourcing may be cheaper when compared to internal management.
  - b. A firm which has high amount of debt in its capital structure may not wish to increase it further by investing in technology. It may go for leasing instead of buying.
  - c. The organization may not have trained IT staff and it may be beyond its capability to establish IT department.

The organizations are benefited because firms specialized in providing outsourcing services may have high level of expertise in providing technological services. The organizations utilizing such services may benefit from low technological costs. However, organizations have to take into account the level of control over the technology and the benefits of technology before going for outsourcing.

- iv. **Investment in IT:** There is no definite answer on the question of amount of investment to be made in the field of IT. It depends on how critical is IT to the survival and growth of the organization and the extent of influence over different areas of business. The different reasons for investing in technology are: Cost reduction, improvement in revenues and profits, pressure from competitors or competitive advantage, requirements of law and development of infrastructure.
- v. PC Policy: The important part of rapid computerization and office automation is the availability of Personal Computers or PCs in large numbers at an affordable price. They are small in size and versatile in a large number of applications with high processing speeds. PCs can be stand-alone or hundreds of PCs may be networked with a central computer facility. The adoption of PC policy is justified because every single organization is using PCs and most of the organizations have networked PCs with Internet/Intranet/Extranet facility. The following are the issues that are addressed by a policy on PCs:
  - a. Approved hardware for purchase.
  - b. Software which is recommended for purchase.
  - c. Appointment of appropriate authority to approve and justify the purchases.
  - d. Authority responsible for signing contracts with the vendors for the supply of hardware/software and subsequent training for the users and also after sale service.

- e. The kinds of application which are best served by PCs.
- f. The role of information services in accessing corporate data.
- g. Procedures and policies on sharing of data among different PCs and accessing data from central database.
- vi. **Role of IS Department Manager:** IS department manager plays an important role in developing cooperative relationship between IS department and users. These managers have a wide variety of subordinates reporting to them ranging from computer professionals with technical qualifications to clerical personnel. This department has its effect on all other departments. It is not only responsible for development of organization-specific IT applications, but also for carrying out routine clerical tasks. This department has a large budget and the manager is responsible for investment in hardware and software.
- vii. The Chief Information Officer (CIO): CIO is a senior manager who ensures that the organization uses Information Technology (IT) efficiently, within government guidelines. He defines the IT infrastructure of the organization. This is a new position in many organizations. But with the proliferation of IT, many more organizations may contemplate on creating this position in their organizations. CIO should have experience with strategic and competitive systems, marketing, finance, production and every functional aspect of the firm. He should have the capability to obtain a reasonable or good return on investment made on the IT resources and systems. CIO is also responsible for voice and data communications and office technology. He should be able to positively guide the top management team in the adoption of suitable IT policy in order to achieve strategic goals of the organization.

## 3.4 Principles of Managing Information Resources

The following are the four principles of managing information resources:

i. **Principle I:** The IS department should be managed just like any other unit or division of the business.

The basic principles of management are planning, organizing, staffing, directing and controlling which find their application in different functional areas of business like marketing, finance, accounting, etc. These principles should also be applied to the field of information systems and management. Even though there are certain unique characteristics of IS department, the principles of management apply equally well to the personnel of IS department similar to the personnel of other departments.

ii. **Principle II:** The sole purpose of information systems is to help the organization meet its goals and objectives.

Usually, there exists difference of opinion between CEOs (Chief Executive Officers) and CIOs (Chief Information Officers) of IS department. CEOs believe that CIOs and other personnel of IS department do not have adequate understanding of business process and the industry. They lay more emphasis on the technological aspects of information processing and are more interested in acquiring the latest technology instead of utilizing the present technologies to the maximum possible extent. They also complain that the returns on investment in technology are not adequate. Hence, top management team is usually reluctant to support IT initiatives in the organization.

To overcome this type of problems, good IRM policies emphasize and promote the bonding between the investments in technology with the business goals. Therefore, IS personnel with good IRM practices have sound understanding of the business details and goals such that they continuously strive to discover, innovate and adopt technologies that will enhance and

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strengthen the strategic position of the company. IRM assists IS personnel to serve the rest of the organization in a better way and help it achieve its mission and goals. Thus, CEO and CIO can become partners rather than adversaries.

iii. **Principle III:** IRM is the responsibility of all managers, regardless of their discipline or function.

Irrespective of their functional areas, information has become a valuable resource for all the managers. Therefore, all functional managers are involved either directly or indirectly in the creation, collection, storage, use, manipulation and dissemination of information. Hence, IRM should not be considered only as a matter of interest of IS department. This consideration may lead to inefficient management of information and its negligence.

Those organizations which believe in the power and potential of information systems in the achievement of their goals lay emphasis on the fact that IRM is an effort which covers the entire organization. Thus, functional managers should be held responsible not only for their functions but also for the management of information generated by their units. The goal of integrated, cross-functional and customer-oriented systems can be achieved only if IRM becomes the main focus point of corporates.

iv. **Principle IV:** The commitment of top management is the key to realizing the full potential of information resources.

The top management is responsible for taking all the strategic decisions of the organization. The policies, programs, goals and missions of the organization are designed by the top management. Decisions about IT and information resources are also strategic decisions because in today's competitive world, companies will be left behind if they do not ride the IT wave. Thus, top management has to extend its total commitment to the selection and use of technology. It also has to provide proper budgetary support for its adoption. If the top management shows reluctance in the matter of IT, then it becomes impossible to change the attitude of employees towards computerization and IT. Top management has to keep in mind the long-term goals of the organization which are dependent on the adoption of IT. Hence, top management has to be well-versed in the management of information systems and technology even though they may not have knowledge about the technical details of IT systems. IRM will provide top managers with good technology management skills while the onus lies on the IS department regarding technical responsibilities.

# 4. DATABASE MANAGEMENT

Information is regarded as one of the scarce resources of the organization like capital, machines etc. The quality of information depends on the quality of data collected in a systematic manner. Data is logically organized into characters, fields, records, files and databases in a way similar to writing text which can be organized into letters, words, sentences, paragraphs and documents.

Before the introduction of databases, the data was stored in traditional file-based systems. However, there were many problems associated with traditional file-based systems which motivated organizations to store their data in databases and acquire a Database Management System (DBMS). There were five main problems which encouraged the adoption of DBMS. These problems are:

- Data was stored in files but information retrieval was not fast and efficient. Managers were unable to get quick answers to simple ad hoc requests.
- The cost of developing and maintaining files was very high.

- System transmigration with existing data was difficult.
- The quality of data that can be stored with the existing system and data integrity was low.
- There were no proper data models to represent real world data.

The logical data elements in a personnel database is shown in the figure 5.

#### Figure 5: Logical Data Elements in Information Systems

Personnel Database											
General Administration File Payroll File											
Employee Record # 1			Employee Record # 2			Employee Record # 1			Employee Record # 2		
Name Field	Employee No. Field	Designation Field	Name Field	Employee No. Field	Designation Field	Name Field	Employee No. Field	Salary Field	Name Field	Employee No. Field	Salary Field

Following is the logical, organization of data in information systems:

- i. **Character:** It is the most basic logical data element that consists of a single alphabetic, numeric or other symbol. This logical data element can be observed and manipulated. It occupies a single basic or elementary unit of a database.
- ii. Field: This is a single piece of information as it consists of a group of characters. For instance, when a group of different alphabets are put together then the field person's name is formed and is referred to as the name field. Similarly, the addition of numbers in a sales amount forms a sales amount field. A field can have various attributes (i.e., a characteristic or quality), for instance, if a field contains numeric data then it has a numeric attribute. A data field represents an attribute of some entity (i.e., an object, place or an event).
- iii. Record: A record is a collection of related fields of data which are grouped together. A record represents a collection of attributes that describe an entity. A record consists of fields. For instance, a payroll record of a person may consists of three data fields: Name, Social Security Number and Rate of pay. Fixed length records contain a fixed number of fixed length data fields while variable length records contain a variable number of fields with variable field lengths.
- iv. **File:** A file or a table is a collection of group of related records. For instance, an employee file would contain records of the employees of a firm. The files are named based on their application in a particular area. For instance, a file used in the area of payroll is referred to as payroll file. A file used in the field of inventory management is known as inventory file. Almost all the information stored in a computer must be in a file. The different types of files are data file, text files, program files directory files etc. Based on the type of data stored in a file, it is named as document file or a graphical image file. It may also be possible to name the files based on the nature of the records. For instance, a transaction file may contain records that are used to carry out day-to-day or monthly transactions. A master file may contain records which have become a part of history with the passage of time.
- v. Database: It is an integrated collection of logically related records or objects. A database consolidates records previously stored in separate files into a common pool of data records that provides data for many applications. According to British computer society, A database is a collection of

structured data. The structure of the data is independent of any particular application. According to Certified Institute of Management Accountants (CIMA), a database is a file of data structured in such a way that it may serve a number of applications without its structure being dictated by any one of those applications, the concept being that programs are written round the database rather than files being structured to meet the needs of particular programs.

In a database, data is organized in such a way that the computer program can easily retrieve the data for processing and produce result as per the program instructions. The data stored in the database is independent of both the application programs that use the data and the secondary storage devices. Another concept in the database design is the Hypertext database. In Hypertext database, a picture, text or a film can be linked to another picture, text or a film. When an object (i.e., a text, film or a picture) is selected then the user can observe the related objects that are linked to it. For instance, in an inventory database, a phrase, "machine breakdown" may be selected by clicking the mouse. This selection will display information regarding the number of machines that stopped working in an entire year or in a particular month and the number of working hours lost. Information from the database can be accessed by means of Database Management System (DBMS).

## 4.1 Components of Database Environment

Following are the components of Database environment:

- i. **Computer-Aided Software Engineering (CASE) Tools:** They are automated tools used to design databases and application programs.
- ii. Repository: It is the centralized knowledge base for all data definitions, data relationships, screen and report formats and other system components. A repository contains an extended set of metadata which is important for managing databases as well as other components of an information system.
- iii. Database Management System (DBMS): It is the commercial software (and sometimes hardware and firmware) system which is used to define, create, maintain and provide controlled access to the database and also to the repository.
- iv. **Database:** An organized collection of logically related data, usually designed to meet the information requirement of multiple users in an organization.
- v. **Application Programs:** They are computer programs that are used to create and maintain the database and provide information to users.
- vi. User Interface: They are languages, menus, and other facilities by which users interact with various system components such as CASE tools, application programs, the DBMS and the repository.
- vii. **Data Administrators:** Persons responsible for the overall information resources of an organization.
- viii. **System Developers:** Persons such as systems analysts and programmers who design new application programs.
- ix. **End-users:** Persons within an organization who add, delete, and modify data in the database and who request for or receive information from it.

## 4.2 Categories of Databases

The different categories of databases that are found in computerized environments or organizations are:

- i. **Operational Databases:** As the name suggests, these databases are helpful in carrying out the operations of the organization. They are also known as Subject Area Databases (SADB), transaction databases and production databases. Examples include customer database, personnel database, inventory database and other databases which come into existence due to business operations.
- ii. Analytical Databases: These databases contain data and information extracted from selected operational and external databases. These databases are intended to provide summarized data and information for managers of an organization and end-users. They are also known as management databases or information databases. These databases use multi-dimensional database structures to organize data and hence they are also known as multidimensional databases. Information systems like OLAP, DSS and EIS access data from these databases.
- iii. Data Warehouse: The term 'Data warehouse' was first given by W H Inmon. Data warehouse is defined "as subject-oriented, time variant, integrated and non-volatile collection of data in support of decision-making process." A data warehouse is a central storage area for all or significant parts of the data that are collected by various business systems of an enterprise. It is a repository of historical and current data related to the business process of a company which is stored in an organized format. This central source of data is screened, edited, standardized and integrated so that it can be used by managers and other professionals for business analysis, market research or decision-making. Data warehouse is stored on the mainframe server of an enterprise. It may be subdivided into data marts which hold subsets of data from the warehouse. Data which is generated through Online Transaction Processing (OLTP) applications, non-transaction applications and other sources is extracted on a selective basis and it is structured and organized on a data warehouse database to satisfy user queries. The data stored in a data warehouse is very useful for management when it is converted into business information. Another useful application of data warehouse database is data mining. In data mining, data from the data warehouse database is processed to find out or identify any underlying pattern of business activity.
- iv. **End-user Databases:** These databases are a collection of data files developed by end-users at their workstations. For instance, users may download files from different sources with the help of Internet and WWW, or may have text, graphic, video or audio files sent by other users through E-mail. All this data is stored in these databases.
- v. External Databases: Organizations or users may obtain a large amount of information from databases that are outside the purview of their sphere of influence. This information may be available free or a fee may have to be paid for it. Websites provide access to hyperlinked pages of multimedia documents in hypermedia databases. The data may relate to, for instance, different fields like statistics, demography, politics, art, science, culture, etc. In addition, there are hundreds of newspapers, magazines, research journals/articles, full text databases, etc., which may be of interest to a group or organization for different purposes.
## 4.3 Data Manipulation Language (DML)

Data Manipulation Language (DML) is a language for manipulation of data in a database by means of an application program and/or by directly end-users. Data manipulation is carried out in order to retrieve, insert, delete or modify information in the database. The language which is helpful to perform these operations on a database in a routine manner is the DML. There are two types of DML. They are: **procedural** DML where the user specifies what data is needed and how to get it and **non-procedural** DML where the user only specifies what data is needed. A **query language** is a portion of a DML involving information retrieval only. The terms DML and query language are often used synonymously.

Following are the basic DML commands:

#### INSERT

The INSERT command in SQL is used to add records to an existing table.

#### SELECT

The SELECT command is the most commonly used command in SQL. It allows database users to retrieve the specific information they desire from an operational database.

#### UPDATE

The UPDATE command can be used to modify information contained within a table, either in bulk or individually.

#### DELETE

The DELETE command can be used to delete that information from the table which satisfies the conditions set by the user.

The SQL uses various clauses in combination with the fields and the DML commands to manipulate data in a database.

#### 4.4 Database Structures

In all information systems, data resources must be organized and structured in some logical manner which will simplify the process of accessing, processing, retrieval and management of data resources. The development of technology has devised different methods, some of which are simple while others are complex. In this chapter, we shall consider different database structures.

i. **Hierarchical Structure:** Hierarchical Database Systems (HDS) has a tree structure. The origin of a data tree is referred to as the root which is unique in HDS. Data is located in different levels along a particular branch from the root. The data structure at each level is called a Node. The last node in the series is a Leaf. The organization in HDS can be considered a structure having a 'parent-child' relationship and also a relationship among the 'Siblings'. Therefore, HDS supports one-to-many relationships.

The nodes of the tree are the record types representing the entity sets and are connected by pointers or links. The relationship between the entities is represented by the structure of the resulting ordered tree. The programmer has to first define the initial structure while creating the database. After defining the initial structure, the parent-child relationship cannot be altered without disturbing the entire structure. The hierarchical data model restricts each record type only to one parent record type.

ii. **Network Structure:** The Network structure of database system helps in establishing many-to-many relationships among records. That is, this network model allows access to a data element by following one of several paths, because any data element or record can be related to any number of other data elements. The Network structure is shown in the figure 6. The relationships between the different data item are commonly referred to as 'Sets'.



In the figure 6, if it is required to know which vendor(s) sell item 2, then DBMS searches the item class and follows the pointers from item 2 to the two vendors who supply them. Similarly, location of item from the vendor class is also possible.

iii. **Relational Structure:** The Relational model of database organizes data in logical mathematical sets in a tabular form. This model has become more popular than other three database structures. In this model, all data elements within the database are viewed as being stored in the form of simple tables. Each data field is considered a row belonging to the table. Consider the example of this model where data is organized into tables as shown in the table 1.

Vendor Details			Item			Cost		
V.No.	Name	Price	P.No.	Part Desc.	V.No.	P.No.	V.No.	Cost
V1	Company 1	1	P1	Part Desc 1	V1	P1	V1	1000
V2	Company 2	2	P2	Part Desc 2	V2	P2	V2	1500
V3	Company 3	3	P3	Part Dese 3	V3	P3	V3	1000
V4	Company 4	4	P4	Part Dese 4	V4	P2	V4	2000
			P1	Part Dese 2	V2	P2	V2	3000

**Table 1: Relational Database Structure** 

In the above table, vendors are grouped in one table, the description of parts in another and their cost in a third table. Different relationships between the various tables are achieved by mathematical set functions. From the above tables, it is clear that each table has one or more columns with the same names as in another table.

- iv. **Multi-dimensional Structure:** This structure is a variation of the relational model. In a relational model, data is represented in two-dimensional tables. whereas in multi-dimensional structure, as the name suggests, the data is represented in more than one dimension. Multi-dimensional structures are used to organize data and express the relationships between data. Multi-dimensional structures can be thought of as cubes of data and cubes within cubes of data. Each side of the cube is considered a dimension of the data.
- v. **Object-Oriented Structure:** The Object-Oriented (OO) database model is one of the most recent database models. It is considered to be one of the key technologies of a new generation of multimedia web-based applications. The object-oriented database is also referred to as the 'post-relational' database model. It addresses some of the limitations of the relational model. In this model, information is stored as a persistent object, and not as a row in a table. An object consists of data values describing the attributes of an entity, plus the operations that can be performed upon that data. This makes it more

efficient in terms of storage space requirements and ensures that users can only manipulate data as specified the programmers. It also saves space on the disk required for queries, instead of having to allocate resources for the result. The space required is already there in the objects themselves. This encapsulation capability allows the object-oriented model to handle more complex types of data (graphics, pictures, voice, text) when compared to other database structures. A group of similar objects is known as class. Each object in a class is known as instance of its class. All objects in a class share a common definition, although they differ in the values assigned to the variables.

This model supports inheritance; that is, new objects can be automatically created by replicating some or all of the characteristics of one or more parent objects. Object-oriented model does not have a high-level language like SQL. There are both an advantage and a disadvantage for not having a high-level language. Its main advantage is the degree of low-level control of the system it allows the programmer. This gives the programmer the control over how the data is to be stored and manipulated. This can be more efficient than using a general language like SQL, as storage techniques can be optimized for the data being stored. This makes it more efficient in terms of storage space requirements and ensures that users can only manipulate data in the ways the programmer has specified. It also saves on the disk space needed for queries, as instead of having to allocate resources for the results, the space required is already there in the objects themselves.

For instance, in banking transactions, the checking and savings account objects can both inherit the common attributes and operations of the parent bank account object.

## 4.5 Database Management System (DBMS)

A DBMS is a set of computer programs that controls and allows the creation, maintenance, storage, modification and extraction of information from a database by the end-users. DBMS consists of collection of interrelated data and a set of programs to access that data. The collection of data is usually referred to as the Database which contains information about one particular enterprise. DBMS provides an environment which is both convenient and efficient in retrieving and storing database information. They are designed to manage large bodies of information. Data management involves two aspects. One is the definition of structures for the storage information and the second is the provision of mechanisms for the manipulation of information. Database systems are designed to provide safety of information even in times when system crashes. These systems make it possible for several users to access data without giving anomalous results.

There are different types of DBMS to be used on PCs or mainframes. DBMS organizes information in relational, network, flat or hierarchical manner. The different ways of organizing information will have its influence on the flexibility and speed of extracting information. Database management packages are available for micro, midrange and mainframe computer systems.

#### **4.5.1 SERVICES OFFERED BY DBMS**

Following are the services offered by DBMS:

- **Data Definition:** It is possible for users to define the database with the help of Data Definition Language (DDL). With the help of DDL, users can specify the data types and structures and also the constraints on the data stored in the database.
- **Data Maintenance:** Care is taken to see that each record contains information about one particular item.
- **Data Manipulation:** The Data Manipulation Language (DML) provides the facility for the users to Insert, Update, Delete and Sort data in the database.

DML also provides a general facility to put questions and get answers with the help of database. This facility is termed query language. The most common query language is the Structured Query Language (SQL) which has become both a formal and defacto standard language for relational DBMSs.

- **Data Display:** DBMS provides the facility for the user to view data in the database. It provides a facility known as a view mechanism which allows each user to have their own view about the database. A view is nothing but a small subset of the database. For instance, a view may be set up which allows finance department to see the addresses of different organizations providing finance, their term period, terms and conditions for different projects and the rate of interest charged by them. Views help to maintain security by excluding unauthorized users from accessing the database. They also provide a mechanism to customize the appearance of the database.
- **Data Integrity:** The integrity system maintains the consistency of stored data. In addition, the security system prevents unauthorized users from accessing the database. This prevents unauthorized deletion or additions to the existing data. A user-accessible catalog is also present which contains description of the data in the database.

## 4.6 Advantages of Databases

The following are the advantages of using databases in an organization:

- i. **Program-data Independence:** Using databases, data descriptions are stored in a central location called the repository. This property of database systems allows an organization's data to change and evolve (within limits) without changing the application programs that process the data.
- ii. **Minimal Data Redundancy:** In the database approach, the data files are integrated into a single, logical structure. Each primary fact is recorded at a single location in the database. The database allows the designers to control the type and amount of redundancy even though it cannot eliminate it completely.
- iii. **Improved Data Consistency:** Inconsistencies existing in the data and wastage of storage space can be greatly reduced by controlling data redundancy.
- iv. **Improved Data Sharing:** A database is designed in such a way that it is considered the property of the organization. Therefore, to make use of this property, authorized internal and external users are granted permission to use the database and each user is provided one or more user views or logical description of some portion of the database to facilitate the performance of the given task.
- v. **Increased Productivity of Application Development:** Organizations which adopt database approach are able to reduce cost and time for developing new business applications. In addition, database management systems provide a number of high-level productivity tools such as form and report generators and high-level languages that automate some of the activities of database design and implementation.
- vi. **Improvement in Quality:** The database approach provides a number of tools and processes to improve data quality. For instance, integrity constraints can be enforced by DBMS.

## 4.7 Disadvantages of Databases

The following are the disadvantages of using databases in an organization:

i. Due to rapid developments in the field of technology, the complexities associated with database management have increased. This causes problems in data resource management.

- ii. Small organizations find the development of large databases with complex data types and installing a DBMS, a difficult and expensive task.
- iii. As the size and operations of an organization grow by the day, more hardware capability is required since there will be an increase in organization's data, overhead control data and the DBMS programs.
- iv. An increase in processing times may result from high volume transaction processing applications since an extra layer of software (the DBMS) exists between application programs and the operating system.
- v. The centralized databases of an organization are vulnerable to errors, fraud and failures. In case of distributed databases, problems may arise due to inconsistency of data. Thus, data resource management of an organization has to ensure the security and integrity of the databases.

## 4.8 Relational Database Management System

The Relational Database Management System (RDBMS) is an important development in the field of database management. This system was developed ten years later than the network and hierarchical systems. The logical approach and the mode of I/O operations in relational system are much different when compared to other systems. In RDBMS approach, data is organized into tables called relations, each of which is implemented as a file. In relational terminology, a row in a relation is called a tuple and it represents a record or an entity. A column in a relation represents a field or an attribute implemented as fields. For instance, a customer relation consists of a number of customer entities. The characteristics of a customer entity are described by its attributes such as customer number, customer name and customer address.

#### **4.8.1 CHARACTERISTICS OF RDBMS**

The following are the characteristics of RDBMS model:

- i. The relational data management model eliminated all parent-child relationships and instead represented all data in the database as simple row/column tables of data values.
- ii. A relation is similar to a table with rows/columns of data values. The rows of a table are referred to as Tuples and the columns are referred to as Attributes. Several tuples of equal length placed one below the other create a table.
- iii. Each table is an independent entity and there is no physical relationship between tables.
- iv. Most data management systems based on the relational model have a built-in support for query languages like ANSI SQL or QBE (Query By Example). These queries are simple English constructs that allow ad hoc data manipulation from a table.
- v. Relational model of data management is based on set theory. Built-in query language is designed in the RDBMS, so that it can manipulate sets of data (one or more tuples).
- vi. The user interface used with relational models is non-procedural because only what needs to be done is specified and not how it has to be done. Use of any of the other methods requires not only to specify what needs to be done but also how it has to be done.

#### 4.9 Distributed Database Management System

A Distributed Database Management System (DDBMS) consists of a single logical database that is split into a number of fragments. Each fragment is stored on one or more computers under the control of separate DBMS, with the computers connected by a communications network. There may be duplicate fragments at more than one site. The data at each site is under the control of a

DBMS. Each site is capable of independently processing user requests that require access to local data (that is, each site has some degree of local autonomy) and is also capable of processing data stored on other computers in the network. The computers in a distributed system communicate with one another through various communication media, such as high speed networks or telephone lines. They do not share main memory or disks. The computers in a distributed system may vary in size and function, ranging from workstations to mainframe systems. Users access the distributed database through applications. Applications may be local (i.e., which require data from other sites) or global (i.e., those that do not require data from other sites). Each DBMS participates in at least one global application. The DBMS at each site can handle local applications, autonomously as shown in the figure 7.



#### 4.9.1 ADVANTAGES OF DDBMS

Following are the advantages of DDBMS:

- i. **Reflects Organizational Structure:** Most of the organizations have branches at several locations. Therefore, databases used in such organizations are also distributed across these locations. Each unit creates its own information systems and these units can have local data over which they can have local autonomy.
- ii. **Improved Shareability and Local Autonomy:** When an organization is distributed geographically then the data is also distributed. Users at one site can access data stored at other sites. Data can be placed at the site close to the users who normally use that data. In this way, users have local control of the data, and they can consequently establish and enforce local policies regarding the use of this data. It is the responsibility of Database Administrator (DBA) to manage the entire system.
- iii. Improved Availability: In a centralized DBMS, a computer failure terminates the operation of the DBMS. But this problem does not arise in case of Distributed Database Management System (DDBMS). In DDBMS, if a single node fails, the system may be able to reroute the failed node's requests to another site.
- iv. **Improved Reliability:** In DDBMS, the same data may be found at more than one site. Hence, the failure of a node or a communication link does not necessarily make the data inaccessible.
- v. **Improved Performance:** The data is located near the site of 'greatest demand', and given the inherent parallelism of distributed DBMSs, speed of database access may be better than that achievable from a remote centralized database. Furthermore, since each site handles only a part of the entire database, there may not be the same contention for CPU and I/O services as characterized by a centralized DBMS.

- vi. **Cost Advantage:** In DDBMS, different corporate divisions and departments have separate computers which make it possible to add workstations at a reduced cost to a network than to install and update a mainframe system. This is possible because a system of small computers have equivalent power of a single large computer. DDBMS allows the partitioning of the application and processing data locally at each site.
- vii. **Modular Growth:** The expansion of existing system by adding new sites to the network is much easier in a distributed environment. The size of the database can be handled by adding processing and storage power to the network.

#### 4.9.2 DISADVANTAGES OF DDBMS

Following are the disadvantages of DDBMS:

- i. **Complexity:** A distributed DBMS that hides the distributed nature from the user and provides an acceptable level of performance, reliability, and availability is inherently more complex than a centralized DBMS. The appearance of same data at more than one site enhances the complexity of the system. In addition to the normal difficulties that may arise in designing a centralized database, distributed DBMS has to take into account the factors like fragmentation of data, allocation of fragments to specific sites and data replication.
- ii. **Cost:** The procurement and maintenance costs for a DDBMS are higher when compared to a centralized DBMS. Furthermore, distributed DBMS requires additional hardware to establish a network between sites.
- iii. Security: In a centralized system, access to the data can be easily controlled whereas, in a distributed system, not only access to replicated data has to be controlled but also the security of the network has to be ensured so that unauthorized persons do not find easy access to it.
- iv. **Integrity Controls:** In a distributed DBMS, the communication and processing costs that are required to enforce integrity constraints may be very high.
- v. Lack of Standards: In DDBMS, there are no uniform standards for communication and data access protocols. Thus, the potential of DDBMS is hampered. There are no tools available to transform a centralized DBMS into a distributed DBMS.
- vi. Lack of Experience: DDBMS are new and have not been used extensively when compared to centralized DBMSs. Thus for a prospective adopter of this technology, this may become a handicap.

#### 5. INFORMATION SYSTEMS FOR DECISION-MAKING

Generally, managers working in an organization act as decision-makers whose decisions need to have a positive effect on the future. In an organization, decisions may be taken by an individual based on his experience, training, cognitive skills, intelligence and knowledge. To some extent, decisions are taken by a computer and those decisions are structured and programmable decisions and the systems which come under this category are robots and automation of a factory. These electronic machines can accept messages in some language and process this information by comparing it with their stored reservoir of knowledge. Decisions can also be taken by a group or a team in an organization. Example of such a group includes Chief Executive Officer (CEO) and members of the board of directors. Information systems should support the activity of decision-making that would result in a positive effect on future. In the present times, databases and webbased resources accessed through effective communication devices help in retrieving information about the past in the shortest possible time.

A decision-maker also needs to make decisions for the future. For instance, strategic decisions are made for a period of five to ten years. To make a prediction about the future and take decisions accordingly, a decision-maker either has to use intuition or make use of tools. An effective information system would come handy in forecasting the future. Such systems also support the production of comparative reports of assessment in order to take alternative decisions. For instance, Structured Query Language (SQL) can be used along with spreadsheets and simulation software.

One needs to know the difference between problem-solving and decision-making. Problem-solving is an activity that is undertaken to satisfy some known need or it can be considered a thought process before a choice is made. On the other hand, decision-making involves solving of problems.

Managers need information systems to aid decision-making because they have certain constraints. The constraints may be that human capacity to process the contents is limited to only seven variables. In addition, under pressure to make a decision would result in an undesirable strategy. Economic factors also have a role in hiring decision-makers.

The importance of information systems particularly useful to the managerial personnel has increased to such an extent that the very survival of an organization depends on the information collected from different sources. The volumes of data available to managers cannot be processed by them in a short period of time without the aid of information processing systems. Thus, managers effectively depend on the information systems. While some organizations have MIS departments, other business organizations also take the help of other specialized organizations which specialize in collection, formulation and distribution of information for a fee.

#### 5.1 Simon's Decision-Making Framework

In this framework, the process of decision-making as undertaken by the managers is examined. The process of decision-making consists of three stages. They are:

- i. **Intelligence:** In this stage, the decision-maker (i.e., manager) recognizes that there is a problem or opportunity that requires him to make a decision. The problem might be related to reduction in profitability caused by increase in the prices of goods due to imposition of taxes by the government or the problem of shortage of raw material (caused by war or natural disasters) which is critical for the production of goods and services. Opportunity may have arisen on account of signing of free trade agreement by the government with a neighboring country.
- ii. **Design:** In this stage, alternative course of action to solve the problem or utilize the opportunity is explored.
- iii. **Choice:** In this stage, one of the alternatives generated in stage (ii) is chosen and this alternative is put into operation to achieve the goal.

#### 5.2 Major Classes of Decisions

The major classes of decisions are as follows:

i. **Programmed Decisions:** The decisions which are routine and repetitive and which can be handled with the help of mathematical models in their entirety are known as programmed decisions. Let us consider an example of programmed decision. In a manufacturing organization, raw materials are a part of inventory and are used to produce output. The raw materials are supplied by the suppliers. An order for raw materials placed with the suppliers is an example of programmed decision. There is a definite procedure for placing the order. Ordering of raw materials is done either after a fixed period of time or when the quantity of raw materials falls below a

certain level. In such a case, the manager knows before hand when to take the decision (of placing the order). Thus, the decisions to be taken are well-documented before a known event occurs.

- ii. Non-programmed Decisions: In contrast to programmed decisions, non-programmed decisions are those that do not have a well-defined procedure. Non-programmed decisions have to be taken under special situations. The events which warrant non-programmed decisions are those which have not occurred before. Most of the decisions taken by top management team are non-programmed decisions. Such decisions are to be taken based on the decision-maker's knowledge, experience and competence. The events occurring in such cases cannot be defined in logical or mathematical terms. An example of non-programmed decisions is the decision to enter a new market of a foreign country or the decisions taken by military generals in war situation.
- iii. Semi-programmed Decisions: In these types of decisions, at least one and not more than two of the three stages of decision-making (as in Simon's framework) can be handled by a well-defined preset procedure. For example, the intelligence stage may be well-structured with diverse kinds of variance analysis in formulating a budget. The comparison between the actual budget and standard budget has a well-defined procedure. However, the subsequent stages of design and choice do not have set procedures.

## 5.3 Executive Information Systems (EISs)

Executive Information Systems (EISs) are management information systems which are designed to meet the strategic information needs of top management. They provide selected and summarized information for senior executives. They combine many of the features of MIS and DSS. The top management has to take strategic decisions which affect the survival and working of entire organization. EIS provides top management with immediate and easy access to selective information about key factors, their current status and their future trends which have a major influence in achieving strategic goals and objectives. EISs are easy to use, operate and understand. With the increasing popularity with top management, it is also being used by middle management. Among the popular alternatives of EIS are Executive Support Systems (ESSs) and Enterprise Information Systems (EISs). In an EIS, information is presented in a form which is compatible with the specification, preferences and requirements of the executives. For instance, most EISs use a Graphical User Interface (GUI) that can be modified according to the information requirements of managers. In other cases, EISs can include exception reporting and trend analysis. EIS also provides ability to drill down, which helps executives to quickly retrieve displays of related information with minute details. The internet and intranet technologies have added web browsing facility to EIS. Some of the features commonly found in an EIS are - Query facilities, Internal data, External data, Excellent color graphics, Explanation facilities, Touch screens, Voice command and Pull-down menus.

EISs are used personally by managers and it is thus essential that it is compatible with the requirements of the managers. Thus, managers must be involved in the development and implementation of the system. Managers may be requested to specify their data requirements and information needs so that the system may be designed to satisfy them. This is because it is difficult to predict their changing

needs and requirements. A technique known as prototyping is widely used in the development of EIS and similar systems.

**Prototyping:** It is based on the simple idea that people can express more easily what they like or do not like about an actual working system rather than predict what they would like to see in an imagined, future system. The four steps of Prototyping are:

- i. Identify the user's basic requirements.
- ii. Develop an initial prototype.
- iii. With the help of real data and problems, the user works with the prototype so that he gains hands-on experience, finds problems, clarifies his requirements, tests assumptions and gains deeper understanding and knowledge.
- iv. Revision of the prototype. Based on the feedback from step (iii), the prototype is revised and enhanced.

#### **Definition of EIS**

Executive Information System (EIS) is a program that allows top managers to quickly retrieve, analyze, and disseminate data and information.

#### **5.3.1 COMPONENTS OF EIS**

The components of EIS can be divided into the following categories:

- i. **Hardware:** EISs require large amount of storage space. Hence, they were developed as solutions to be implemented in a mainframe environment. EISs require large amount of data space because data is collected from all the areas of business. In addition, the disk space should also support any further upgradation or modifications to EIS that may be carried out in future.
- ii. **Software:** Software plays an important role in the design of EIS. It is used to manipulate data. Software components and their integration into the system play an important role. Some of the software that are used are as follows:
  - **Text based Software:** A number of word processing softwares are available in the market. EIS has the capability to retrieve and manipulate the document based on certain keywords. The advantage of text-based documents is that a number of documents can be taken together and the contents of the documents can be pasted in a single document. Thus, different data from a number of documents is available at one place to the decision-maker.
  - **Database:** A database is a collection of large number of files. Each file has records. The files in a database can be accessed in different ways. The records in a file can be added, deleted, modified and updated. Relational databases provide flexibility.
  - **Graphic Base:** A number of graphic tools are available that can be used to present data in a particular format. For instance, data can be presented as time series charts, scatter diagrams, maps, motion graphics, sequence charts, and comparison-oriented graphs (i.e., bar charts) etc. The graphical presentation of data quickly conveys the inherent message of the data. For example, when sales data is presented in a graph with quantity of sales plotted on the Y-axis and years on the X-axis then the decision-maker can quickly grasp the variation of sales with time. It can also show the quick comparison between the sales data of adjacent years. Similarly, a pie diagram shows the percentage of sales of various

products in terms of angles in degrees. Thus, large amount of data can be summarized by using the graphical tools.

• **Model Base:** The real or planned situations can be depicted as a model. These models are built on a very small scale and they are representatives of the original situations. A problem can be structured by using a model. The entire set of operations and the results can be shown and predicted by constructing a model. Thus by using a model, the output of the real life event can be known without spending huge amount of money. In EIS, models are constructed for analysis of statistical, financial and other quantitative analysis. The four different categories into which models can be classified are shown in the Table 2.

Type of Model	User of the Model	Description of the Model	Applications of the Model
Strategic	For Top-level managerial personnel	Decisions that affect the entire organization and which involve a period of more than five years.	<ul> <li>Mergers and acquisitions</li> <li>Entering international markets</li> <li>Determining the location of Plant</li> </ul>
Tactical	For Middle- level managerial personnel	Decisions involving allocation of resources to carry out the implementation process.	Scheduling the design of Floor space.
Operational	For Lower- level managerial personnel and analysts	Decisions that need to be taken on routine basis every day.	<ul> <li>Cash forecasting</li> <li>Payroll</li> <li>Recruitment of workers</li> </ul>

Table 2.	Model	Classifications
Table 2:	widdei	Classifications

iii. **Interface:** There are several types of interfaces that can be built into the EIS structure such as scheduled reports, questions/answers, menu-driven, command language, natural language and input/output type.

The ideal interface for EIS should have the following characteristics:

- Simple to use.
- Maintenance of consistent performance.
- Representative of executive's world.
- Built-in facility to provide help in using EIS and display error messages when user inputs non-compatible data or tries to perform any operations whose results are undefined.
- Highly flexible so that any modifications or additional features can be incorporated into it.
- iv. **Telecommunications:** Organizations have grown in size and complexity. The branches and subsidiaries exist in many countries. Therefore, decentralization in the matter of administration is being followed in almost all the organizations. Thus, telecommunications play an important role in coordinating different business units of the company. A reliable electronic network has to exist between different business units so that they can maintain lines of communication with one another and also with the headquarters of the company. This will also serve as a means for accessing

distributed data and decision-making in a short period of time. Thus, the importance of telecommunications within an EIS has grown rapidly.

Thus, effective integration of computer hardware and software necessary to manage text, data, model, and graphic-based system with a friendly interface and a reliable telecommunication network, requires a constant focus on these factors.

#### **5.3.2 ADVANTAGES OF EIS**

- i. Higher-level executives can use EIS in a simple manner.
- ii. Executives with minimal computer knowledge can also use EIS.
- iii. EIS provides the information relating to the company in a summarized form in right time for the executives.
- iv. Executives can enhance the understanding of information with the help of EIS.
- v. Only relevant data is provided so that the time taken by the executives to take a decision is reduced considerably.
- vi. Information collection and its subsequent processing are improved by the use of EIS.

#### **5.3.3 DISADVANTAGES OF EIS**

- i. EIS cannot perform complex calculations.
- ii. The benefits to the organization after the implementation of EIS are intangible. Therefore, they are difficult to measure in quantitative terms.
- iii. EIS may overburden the executives with information.
- iv. EIS may become too large for the executives to handle.
- v. There may be high implementation costs of EIS which small companies cannot bear.
- vi. EIS may require additional data requirement which may be underestimated.

#### 5.4 Artificial Intelligence

Artificial Intelligence (AI) incorporates principles from philosophy, mathematics, psychology, neurology, linguistics, computer science, and many other fields. The combined knowledge of these fields is being used for the advancement of AI. It is relatively a new science which has been developed in the last fifty years. It is a rapidly growing field which has many applications in the present world. There are a number of futuristic applications and expectations in the field of AI. AI has been incorporated in the technology domain of computers. Hence, the progress in the field of computer and Information technology will lead to the advancement of AI. In the field of AI, machines and programs are being developed whose behavior might be considered intelligent from the viewpoint of human beings. We know that a programming language is a set of instructions for the computer to solve a problem. An algorithm is written and it is converted into a set of instructions which are to be followed in an order to reach the desired goal. Thus, by following the order of instructions one is sure to reach the destination.

However, AI programs are non-algorithmic. AI programs often employ heuristics or rules of thumb for finding solutions to problems. They are capable of pattern recognition and are used in optical-scanning devices. They read input symbols and compare them with the symbols already in the scanning device to identify the input. Expert systems and neural networks represent an applied branch of the computer science field of Artificial Intelligence (AI).

#### **5.4.1 DEFINITION OF AI**

Some of the definitions of AI are as follows:

- i. Artificial Intelligence is a branch of science, which deals with helping machines to find solutions to complex problems in a more human-like fashion. This generally involves borrowing characteristics from human intelligence, and applying them as algorithms in a computer-friendly way. A more or less flexible or efficient approach can be taken depending on the requirements established, which influences how artificial the intelligent behavior appears.
- ii. Artificial Intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

#### **5.4.2 APPLICATIONS OF AI**

The following are the applications of AI:

- i. **Cleaning the House:** A vacuum cleaner can be designed by incorporating the technological elements of AI. This vacuum cleaner can be taken round the room so that it becomes familiar with the layout of the room and the areas which tend to be potentially dirty. After a few trial runs, it can go round and clean the room on its own.
- ii. Assistance in Writing and Editing Work: AI will find its application in the writing and editing work. It can analyze and correct the spelling of the words and grammatical part of the sentence in a document in the same way as a human editor.
- iii. Security of Houses and Installations: AI enhances the security systems installed to protect houses and installations from anti-social elements. In the security system, cameras are installed to capture the image of the person entering the house or installations. AI system can recognize the images captured by the cameras and if an unauthorized person enters the house or installation then raises an alarm.
- iv. Researching the Net: Search engines are capable of finding web pages requested by the user based on a particular search criteria. But they cannot carry out the search activity narrowly which conforms exactly to the requirements of the user since they cannot understand the intentions of the researcher specified in his natural language. However, search engines which are powered by AI are capable of finding the web pages based on the specifications given by the researcher in his natural language. For instance, with the help of AI, search engines can satisfy the conditions of the researcher like his language constraints in reading web pages and then carry out the search.
- v. Medical Science: In the field of medical science, AI has its application. For instance, doctors can converse with the AI-oriented application program in a natural language to retrieve information from the knowledge database. The application program can provide the information solicited by the doctor and also converse with him freely in the same natural language. Thus, the doctor finds no difference while conversing with a human being who is his assistant and the AI-oriented program.
- vi. Aeronautical Science: Radars fitted with AI components can detect and warn about the potential hazards like wind shears, turbulence, etc.
- vii. **Military Applications:** AI finds its applications in the military field for launching missiles, identification of targets and automatic and autonomous control.
- viii. **Games:** AI finds its application in the field of designing and developing games on the computer systems. The best example in this case is the board games like chess and other games like flight simulators which create virtual

situations where a user gets the experience of flying fighter aircrafts during the times of war.

ix. **Music:** In the field of music, AI can not only compose (create music) but also transpose (i.e., develop written music from listening to different compositions).

#### 5.5 Expert Systems

Expert system is a computer system or a program that is capable of solving problems by using Artificial Intelligence (AI) techniques. They are a part of general category computer applications commonly known as artificial intelligence. Expert system is a computer application that can perform tasks, normally carried out by human beings. Normally, to determine the solution of any problem, we require the services of a knowledgeable human being. Expert systems are knowledge-based computer programs that demonstrate the expertize of human mind in the limited area of knowledge and experience in finding solutions to problems. They provide value-added services to the organization. Value-added work requires special skill or expertise. They are equipped with tools, information and structured methods for decision-making.

In order to take a particular decision, expert systems have stored knowledge and software modules in specific areas. By using their stored knowledge, expert systems can provide suitable answers to the questions raised by the users. Some expert systems are designed to replace human experts in providing solutions to the problems while other expert systems are built only as an aid to human experts. Based on input data stored and software modules, an expert system can diagnose human illness, make financial forecasts and schedule routes for delivery vehicles. For instance, the symptoms of a number of diseases along with diagnostic details as prescribed by a doctor are stored in the knowledge base of an expert system. When a human being provides his symptoms to the expert system, then the expert system compares the symptoms given to it as input data with its knowledge base. When the input data matches the stored data then the expert system can provide the patient with the respective details for diagnosing that disease.

In order to construct an expert system, a knowledge engineer (a person who studies how experts make decisions), extensively questions the experts and develops a set of rules and data which pertains to the way an expert develops solutions to the problems. The material so developed is organized and represented in a format suitable for the computer. A set of tools for inquiry, manipulation and response are also used. Thus the knowledge of the experts is gathered, stored and utilized in expert systems because the expert may not be available at the right time and place to diagnose the problems and suggest solutions. Moreover, the decisions/suggestions given by the expert systems are consistent in nature unlike experts who may have difference in opinion.

#### **5.5.1 DEFINITION OF EXPERT SYSTEMS**

The following are some of the definitions of Expert Systems:

- i. Expert Systems (ESs) also known as Knowledge-based Systems (KBS), are computer programs designed to simulate the problem-solving behavior of human experts within very narrow domains or scientific disciplines (entomology, plant pathology, etc.). This discipline is a subset of Artificial Intelligence.
- ii. An expert system is a computer program where data is stored and manipulated by the program to come up with advice, hints, directions in reaction of input by users of data acquisition devices.

The components of expert systems are shown in the figure 8.

#### Management and Systems

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Figure 8: Components of an Expert System



Some of the examples of expert systems are as follows:

Acquisition

Program

a. INTERNIST is a medical diagnosis tool that contains nearly 100,000 relationships between symptoms and diseases.

Work Station

- b. PROSPECTOR, an aid to geologists in interpreting mineral data.
- c. Expert systems are also used in personal tax planning, product pricing, Air crew scheduling, credit approval in banking, etc.

#### 5.5.2 COMPONENTS OF EXPERT SYSTEMS

The following are the components of expert systems:

i. **The User Interface:** It is an extremely important component of an expert system. It facilitates interaction between the user and the computer by accepting input from the user and displaying different kinds of output. It is the means of communication with the user. The hardware components of interface which help to input data are keyboards, mice, sound cards and voice recognition systems, and the output devices are printers and terminals. The software components of interface include pull-down menus, graphs, charts, icons, touch screens, and natural language interfaces.

The utility of a system can be enhanced with the help of user interface. The quality of interface depends on the type of output the user obtains, the facts that user must know in order to comprehend and act on the basis of output and the actions that a user must take in order to accomplish goals on the basis of system output. In the past, user interface was not given due attention. A good interface makes it easy for the user to use and adopt the system.

ii. The Knowledge Base: It is a repository of factual and heuristic knowledge. A knowledge base is more logically oriented than a conventional database. Knowledge base contains vast amount of knowledge in a particular subject area like engineering and medicine which helps experts to solve problems in that area. The two categories of knowledge are Deep knowledge (which includes general theories, first principles and axioms) and Surface knowledge (which is acquired through experience and consists of mostly heuristics and rules of thumb) Knowledge representation schemes are provided by an expert system tools for expressing knowledge about the application domain. Some tools use both frames and IF-THEN rules. IF-THEN rules specify the actions that the system should take if a certain set of conditions are satisfied.

The frame provides a way to gather lot of information at one place about an object. For instance, a frame might contain the characteristics of a number of refrigerators including its compressor power, amount of current it consumes,

etc. Thus, this expert system might be able to advise us on the type of refrigerator to buy. An expert system can use semantic network. There are a number of nodes in a network and information is present across these nodes. The program traverses the nodes along the paths of the network when it is seeking information for carrying out computations.

- iii. **The Inference Engine:** It is a piece of software which has the ability to apply reasoning and draw inferences. It determines what knowledge to apply, when to apply and how to apply in order to solve a given problem. It guides and controls the problem-solving process and arrives at conclusions by applying reasoning to the knowledge stored in the knowledge base.
- iv. **The Working Memory:** It is the fourth component of an expert system and is commonly referred to as the "blackboard". It provides a temporary storage for data to be used in problems at hand. During the process of problem-solving, the working memory holds the data during intermediate stage and also the final values obtained after the completion of problem-solving process. It maintains a record of three things:
  - The plan of action for solving the problem,
  - The actions that need to be implemented to solve the problem, and
  - The alternative courses of action that can be taken to solve the problem.

## 5.5.3 LIMITATIONS OF EXPERT SYSTEMS

- i. Expert systems do not have common sense like human beings.
- ii. It is not possible to make expert system learn any thing.
- iii. It is difficult to validate expert systems.
- iv. Expert systems require large amount of financial resources to install and maintain.
- v. Expert systems are sometimes overrated. It means that the user expectations from expert systems exceed their capabilities.
- vi. It is difficult to elicit the knowledge of experts.

#### 5.6 Geographical Information Systems

Geographical Information Systems (GIS) are a special category of DSS that integrate computer graphics and geographic databases with other DSS features. A GIS combines different pieces or layers of information so that more knowledge is gained about a particular place or location. The choice of different pieces of information that are to be put together or combined depends on the purpose or aim of the user or professional. A user or professional may require information about a particular location in order to establish a shopping complex or a scientist may need information about a particular place in order to study the impact of environmental conditions on the nuclear plant to be established at that location.

The following are the requirements of GIS:

- i. Hardware: It includes computers and peripherals.
- ii. **Software:** It provides functions and tools which are helpful to store, analyze and display information about places. It ties data to points, lines, and areas on a map. A large variety of GIS software is available for a number of tasks like display of business areas for sales or software to study the large tracts of land reserved for flora and fauna. The important components of GIS software are:
  - Tools that facilitate the input and manipulation of geographic information such as addresses or political boundaries.
  - A Database Management System (DBMS).
  - Tools that create intelligent digital maps that can be analyzed, queried for more information, or printed for presentation.
  - An easy-to-use Graphical User Interface (GUI).

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- iii. Data: The sources of data for GIS are commercial, non-profit, educational or governmental sources, own organization of the user or other GIS users. The data may be available in the form of proprietary and standard map and graphic file formats, images, CAD files, spreadsheets, relational databases, and other sources. The data to be collected may be available free of cost or a may be paid, for obtaining it.
- iv. **People:** People are required for GIS-related work in the areas of physical and natural science, social information, mathematics, communications, technology and other fields of study. The jobs in the field of GIS are varied and pervasive.
- v. Training: A user of GIS or a professional in the field of GIS both require some form of education or technical training. GIS applies a scientific process to the tasks for which it is used. Therefore, training is essential to understand the process and apply it in proper perspective. The four main methods of learning GIS are: Formal degree or certification obtained in a university, Class room training offered by instructors and arranged by GIS vendors or partners, Online web-based training offered to the learners at the place and time of their convenience and self-study undertaken by users or professionals using workbooks and CD-ROMs.

#### 5.6.1 ADVANTAGES OF GIS

The following are the advantages of GIS:

- i. GIS can be used when natural disasters occur. It can help the government to calculate emergency response times to face natural disasters.
- ii. GIS helps banks in the identification of suitable locations for installing new branches or ATM terminals.
- iii. GIS can be used to support decisions that require knowledge about the geographic distribution of people or other resources in scientific research, resource management and development planning.
- iv. With the help of models available in GIS, managers can change data and automatically revise business scenarios to choose the best solution from a range of available solutions.
- v. Small businesses can also afford GIS tools, some of which can be implemented through the Web.

## SUMMARY

- Information plays a vital role for the management in carrying out the management functions planning, organizing, and control, staffing and decision-making. Information provided to the organizations was collected from commonly known sources like data processing applications.
- Managers can satisfy their queries by retrieving data from databases and data warehouse with the help of computer-based query languages and application programs. Computers can process numerical data and perform calculations at very high speeds.
- In addition to computers, Internet, Electronic Data Interchange (EDI), printers, scanners, application software etc., have increased the scope and reliability of MIS.
- A Management Information System is an integrated man-machine system that provides information to support the planning and control functions of managers in an organization.
- The characteristics of MIS are comprehensiveness, co-ordination, subsystems, integration, transformation of data into information, enhancement of productivity, compatibility, relevant information, quality criteria, feedback, flexibility, modularity, selective sharing of data, etc.

- Management can be viewed as structured into three hierarchical levels. They are: The top-level or the strategic level, The middle-level or the tactical level, and The bottom-level or the operational level. At top-level, MIS is concerned with determining, maintaining and supplying information required by top-level management. At middle-level, MIS is concerned with information that is necessary to elaborate, clarify and operationalize organizational goals formulated by the top-level management. At bottom- level, MIS is concerned with providing information to regulate and coordinate the programs and operational plans to produce goods and services.
- Data is logically organized into characters, fields, records, files and databases in a way similar to writing text which can be organized into letters, words, sentences, paragraphs and documents.
- The database refers to the collection of large number of files. The data is stored in the files in the form of records. The data or the records can be accessed from a particular file by the users.
- The features of databases are inconsistency, redundancy, independence, reliability, access to shared data, centralized control of data, etc.
- The accounting field consists of two major areas. They are financial accounting and management accounting. Financial accounting measures the income for a specific period of time usually one financial year and also reports financial status at the end of the period. Management accounting is designed to help the management in taking relevant financial decisions.
- Organizations have to transact with a large amount of data and carry out innumerable numerical calculations that deal with accounting, financial and banking data. With the help of computers, organizations can perform routine and repetitive calculations involving large amount of data within a short period of time.
- System is an entity, conceptual or physical which consists of interdependent parts or components. The various parts of the system are interdependent on one other. In a system, there are many processes which have reciprocal cause-effect pathways. A system, is made up of subsystems and these subsystems have further subsystems.
- The different types of systems are open and closed systems, static and dynamic systems, adaptive and non-adaptive systems, permanent and temporary systems, deterministic systems, probability or stochastic systems, self-organizing systems.
- A manager is an employee in an organization who has the responsibility of planning and directing the work of a group of individuals who are most of the time other employees, supervising their work, and guiding and correcting their work as and when necessary. In many organizations, there are many supervisors who are guided by a manager.
- The logical organizations of the data in the information systems are character, field, record, file, and database. The different components of database environments are CASE tools, repository, DBMS, database, Application programs, user interface, data administrators, system developers and end-users. The categories of database are operational databases, analytical databases, data warehouse, end-user database, and external databases.
- Data Manipulation Language (DML) is a language for manipulation of data in a database by means of an application program and/or by directly endusers. Data manipulation is carried out in order to retrieve, insert, delete or modify information in the database.
- In all information systems, data resources must be organized and structured in some logical manner which will simplify the process of accessing,

processing, retrieval and management of data resources. The different database structures are – hierarchical structure, network structure, relational structure, multi-dimensional structure and object-oriented structure.

- Hierarchical Database Systems (HDS) has a tree structure. The Network structure of database system helps in establishing many-to-many relationships among records. The Relational model of database organizes data in logical mathematical sets in a tabular form. Multi-dimensional structure is a variation of the relational model. In multi-dimensional structure, as the name suggests, the data is represented in more than one dimension. The Object-Oriented (OO) database model is one of the most recent database models. It is considered to be one of the key technologies of a new generation of multimedia web-based applications.
- A DBMS is a set of computer programs that controls and allows the creation, maintenance, storage, modification and extraction of information from a database by the end-users. DBMS consists of collection of interrelated data and a set of programs to access that data. The collection of data is usually referred to as the Database which contains information about one particular enterprise. The services offered by the DBMS are data definition, data maintenance, data manipulation, data display and data integrity.
- In RDBMS approach, data is organized into tables called relations, each of which is implemented as a file. In relational terminology, a row in a relation is called a tuple and it represents a record or an entity. A column in a relation represents a field or an attribute implemented as fields.
- A Distributed Database Management System (DDBMS) consists of a single logical database that is split into a number of fragments. Each fragment is stored on one or more computers under the control of separate DBMS, with the computers connected by a communications network. There may be duplicate fragments at more than one site. The data at each site is under the control of a DBMS. Each site is capable of independently processing user requests that require access to local data (that is, each site has some degree of local autonomy) and is also capable of processing data stored on other computers in the network.
- Within the framework given by Simon, the major classes of decisions are Programmed decision, non-programmed decisions and semi-programmed decisions.
- Executive Information Systems (EISs) are management information systems which are designed to meet the strategic information needs of top management. They provide selected and summarized information for senior executives.
- Artificial Intelligence is a branch of science, which deals with helping machines to find solutions to complex problems in a more human-like fashion. This generally involves borrowing characteristics from human intelligence, and applying them as algorithms in a computer-friendly way.
- Expert Systems (ES) also known as Knowledge-based Systems (KBS), are computer programs designed to simulate the problem-solving behavior of human experts within very narrow domains or scientific disciplines (entomology, plant pathology, etc.). This discipline is a subset of Artificial Intelligence.
- Geographical Information Systems (GISs) are a special category of DSS that integrate computer graphics and geographic databases with other DSS features. A GIS combines different pieces or layers of information so that more knowledge is gained about a particular place or location.

## **Chapter III**

# **Planning, Implementation, Evaluation and Maintenance of MIS**

## After reading this chapter, you will be conversant with:

- Strategic and Project Planning for MIS
- Strategic Information Systems Plan
- Implementation and Evaluation of MIS
- Maintenance of MIS
- Advantages and Disadvantages of MIS

#### Planning, Implementation, Evaluation and Maintenance of MIS

Planning is one of the management functions and it is the forerunner of implementation stage. The result of organizational planning process is called a plan. Plan develops a blueprint of actions which are necessary to achieve a goal. Planning is described in terms of different levels (i.e., strategic planning, tactical planning and operational planning).

In general sense, planning is deciding in advance what action to take, when to take and how to take. That is, it is about deciding what to do before it is done. Planning is important for achieving success. It is said that a good plan is half the work done. If a considerable amount of time and resources are spent to prepare a blueprint to reach the goal then it is planning. A good plan will bring good results in both long and short run.

Based on the time horizon, planning may be done for the longer or shorter duration of time. Thus, we have long-range planning and short-range planning. Long-range planning as the name suggests, is done for future involving five or more years. This planning takes into account the future scenario of the business viz., its growth, diversification, consolidation, challenges from its environment etc. This planning is mostly done under the domain of top management. However, longrange plans are reviewed and modified periodically, say every six months.

Short-range planning as the name suggests, is done for very short period of time usually for a day, week or month. Examples of short-range planning are development of financial and operating budgets, production scheduling, and planning for the development and implementation of projects.

Planning is very essential to achieve quality control. A proper plan helps to give a clear idea to the employees about the quality management tasks to be undertaken with regard to information systems. In addition, we have noted in earlier sections that investment and selection of information systems and resources is a strategic and irreversible decision which will have long-term consequences for the organization. Therefore, planning would help top management to foresee the effects of their decision and also help them in preparing contingency plans if the proposed information systems do not give the desired results. Planning also helps to search for alternative information systems and resources, keeping in mind the budgetary constraints. It helps to select those technologies and resources which are compatible with the organizational goals.

The organizational planning process consists of:

- i. Team building, modeling, and consensus.
- ii. Evaluating what has been accomplished and the resources that have been utilized.
- iii. Analyzing the business, economic, political and societal environment.
- iv. Anticipating and evaluating the impact of future developments.
- v. Building a shared vision and deciding on the goals to be achieved, and
- vi. Deciding on what actions to take to achieve these goals.

## 1. STRATEGIC AND PROJECT PLANNING FOR MIS

Planning involves looking into the future carefully by assessing the future scenarios and assessing the likely events in the business environment and taking appropriate action to face any kind of eventuality. The following reasons such as market forces, technological change, complexity of business processes, competition and environment make planning an essential management process to keep business in a good condition and are forcing all the organizations to choose strategic business planning. During this process, the top management would periodically formulate the organization's strategy and then communicate it down the organization for implementation. As far as large corporations are concerned, strategy at the corporate level is concerned with managing a portfolio of businesses. For instance, corporate level strategy involves decisions about which business units to grow, resource allocation among the business units, taking advantage of the synergies among the business units and mergers and acquisitions.

While deploying the resources in order to achieve the organization goals, we will go with a decision that is called a strategy. We can classify the strategies into two types such as a right strategy and a wrong strategy. A right strategy can help to achieve goals and a wrong strategy cannot. It is expensive to correct a wrong strategy to make it help to achieve goals. A pure strategy is a strategy, which considers a single point of attack by a specific method, while a mixed strategy is a strategy, which acts on many fronts by different means. Hence, a strategy may fall in any area of business and may deal with any business aspects. The success of an organization depends on the strategic moves and can be classified into the following classes such as overall company strategy, growth strategy, product strategy and marketing strategy.

**Growth Strategy:** It means the selection of a product with a very rapid growth potential and it means the choice of the following industries such as electronics, communication, information technology, transport, textile, plastic and so on where we can find the growth potential for expansion, diversification and integration. It means the acquisition of business of the other firms and opening new market segments. It is adopted to establish, consolidate, and maintain a leadership in the business and industry.

**Product Strategy:** A growth strategy where a company selects a particular product with specific characteristics becomes a product strategy. It means selection of a product, which can expand as a family of products and provide the basis for adding the related products. By way of model, type and price, it can be positioned into expanding markets.

#### 1.1 Introduction to Strategic Planning

Strategic information system's planning deals with the development of an organization's mission, goals, strategies and policies. As mentioned earlier, information systems like computer, telecommunications networks etc., are being widely used in organizations to speed up the processing of data and churning out of information. Thus taking into account the importance of information in the survival of an organization and the competitive advantage it provides, the planning for information systems is an important component of organizational planning.

Strategic planning is the task of top management. The top management takes into account mainly the external environment of business and formulates strategic plan after undertaking SWOT (Strength, Weakness, Opportunities and Threats) analysis. Information systems' strategic planning results in the creation of a blueprint or the design of IT architecture as conceived by top management. The major components of IT architecture are as follows:

- **Technology Platform:** It is the base on which IT architecture rests. It consists of computer systems, system and application software and telecommunications networks which provide the basic computational and communications infrastructure.
- **Data Resources:** Data resources store and process data to produce information for meaningful analysis. The most important data resource used these days is the database which includes operational and specialized databases, data warehouses, analytical databases and external data banks.
- Application Portfolio: IT has given rise to many business applications which are structured as a diversified portfolio of information systems that support key business functions and also help to achieve collaboration among different functional business processes. Application portfolio should also provide facility for business interactions among business partners, managerial decision-making, end-user computing and collaboration and strategic initiatives to achieve competitive advantage.

• **IT Organization:** Multinational business organizations operate from a number of locations throughout the world. Different business activities are undertaken at different locations to benefit from favorable and unique local conditions. Since IT provides the linkage between company headquarters and its affiliates at various locations, therefore a proper distribution of IS personnel should be achieved among the different locations. This distribution depends upon managerial philosophy, business vision and business/IT strategies formulated during the strategic planning process.

## **1.2 Principles of Information System Planning**

Following are the principles of Information System (IS) planning:

- Support the Firm's Business Strategy with Appropriate Technical i Architecture, Standards and Policies: Planning and decision-making go hand-in-hand. One supplements the other. Management has to find a right balance between centralized and decentralized decision-making process. Employees and departments have to coordinate with each other to achieve organizational goals. They should work towards common goal and should not carry out the tasks according to their own whims or opportunities. Even though centralized and decentralized approaches to decision-making have their own merits and demerits, there is a consensus that some issues affecting the entire organization must be taken by a central authority. These issues include building and maintaining systems, the design of information resources and technical standards for hardware (computers etc.) and software (operating systems). Due to rapid changes in business environment and also technological environment, decisions regarding information systems and their operations need to be consistent in the long run.
- ii. Evaluate Technology as a Component of a Larger System: As it is clear from previous discussion, technology is a major driver for business organizations. However, technology should be viewed as a component of larger system and should not be viewed in isolation. It means that technology should be integrated with existing systems. For instance, even though a company may wish to adopt the latest cutting-edge software but if its existing systems (say hardware components like computers, printers etc.) are incompatible with the latest software or are of older version then such integration of hardware and software will not give efficient and economical results. In another instance, the skill and education levels of employees should match the information resources for optimum utilization of the resources.
- iii. Recognize Life Cycle Costs, Not Just Acquisition Costs: A Company has to adopt and install information system resources within the budgetary allocations. In addition, the cost of physical resources (computers, printers, networks etc.) cannot be viewed in isolation. For instance, personal computers are brought for prices. After buying, a number of computers have to be linked to form a network (for instance, LAN or WAN). This again involves an element of cost. In addition, Internet and Intranet also include an element of cost. Thus, before buying computers, company has to take into consideration other related costs involved in process of utilizing computers.
- iv. Design of Information Systems: As discussed earlier in the previous principle, information system resources involve an element of cost. Organizations have to invest in these systems and obtain a return which may be tangible or intangible, commensurate with the investment. Thus, proper attention must be paid towards the maintenance aspect of the information systems so that the organization can derive benefits for a long time. The system must be constructed and documented carefully and the documents be updated whenever the system is changed. It will be easy to maintain a system if it is designed in the form of modular components which function according to the industry standards.

- v. *Recognize the Human Side of Technology Use:* Organizations make huge investments in acquiring and installing technological resources but it is the people/employees who actually use/utilize these systems to produce output/results and thus increase the productivity of the organization. Thus, even though organizations may be constrained to acquire information resources due to financial crunch or other reasons, but active participation of employees who are ever ready to upgrade their skills and knowledge would produce wonderful results with the existing systems. System users should be actively involved in the acquisition, design or development of information systems with proper training.
- vi. Support and Control of the Technical System: Just as cars, houses etc., need proper care and maintenance to prevent them from degradation and also to prolong their life; information systems must also be properly controlled and supported. Otherwise, it may lead to system failure, overloaded databases, faulty documentation or incorrect data processing. Since many functional areas/departments of an organization have their own information system resources, therefore decentralization or outsourcing of maintenance work will be greatly helpful. This is because system users of a particular department or companies, specializing in carrying out outsourced work will have greater technical expertise.

## 1.3 Objectives of Strategic IS Planning

Strategic IS planning has four major objectives. They are:

- a. **Business Alignment:** The vision, mission and strategic goals of an organization are aligned or made compatible with the investment in information technology.
- b. **Competitive Advantage:** Information technology can help in the development of unique business information systems which can provide timely, accurate and reliable information or design of the products and services such that the company can attract customers and establish its foothold in new markets.
- c. **Resource Management:** The Company should make investment in information system resources. The cost of latest IT gadgets like laptop computers, etc., is very high. Hence, proper plans have to be developed for efficient utilization of resources so that they give proportionate returns commensurate with the costs. The resources that have to be managed include IS personnel, hardware, software, data and network resources.
- d. **Technology Architecture:** It involves developing blueprints of information technology architecture and policies for implementing IT in the organization.

#### 1.4 Tactical and Operational IS Planning

- a. **Tactical IS Planning:** It involves the design of tactics, setting of objectives and the development of procedures, rules and schedules and approving budgets. It is the last stage of planning process. Project proposals are designed for the development of new or improved information systems that implement the IT architecture created during strategic IS planning. Then projects are chosen based on the plan. In the end, resource allocation plan is developed to specify the IS resources, financial commitments and organizational changes needed to implement the strategic IT development plan of the organization.
- b. **Operational IS Planning:** This type of planning is done on a short-term basis to implement and control day-to-day operations. It involves detail plans to achieve new information systems development projects which include preparation of operating budgets. Annual operating budgets allocate the predetermined financial and other resources needed for organization's information services operations, systems development and maintenance

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activities. Under operational planning, project planning is an important function. Project planning involves the development of plans, procedures and schedules for an information systems development project. This planning is done mainly to support project management effort.

## 1.5 Strategic Alignment of Business and IT

Strategic alignment of the business and IT is the central theme in strategic information system planning. Figure integrates the business domain with IT domain.

Figure 1: Strategic Alignment of Business and IT



Figure 1 can be divided into two domains: The business domain and the IT domain. The arrows indicate that business domain primarily depends on the IT domain for its needs, opportunities, organization and structure. Therefore, IT should be structured to support the business needs and its strategy. The firm's IT infrastructure is a determinant to the dynamic nature of IT and also a determinant to the processes and applications that can be accommodated in this infrastructure. The work systems carry out company's plans and information systems exist to support work systems. Therefore, the company's IS plan should be compatible with its business plan.

#### 1.6 Problems Related to Information Systems Planning

It has been observed in many organizations that information systems have performance problems in many organizations. The benefits of IT have not been fully realized. Studies conducted by Management consulting firms, computer user groups and university researchers have shown that many business organizations have not successfully managed their computer resources and information services departments. For instance, IT has not been used effectively, efficiently and economically by many companies.

Companies, who used IT to computerize traditional business processes, could not apply it effectively for decision support and innovative processes. Therefore, they have failed to gain competitive advantage. Inefficient use of IT has resulted in poor response times, frequent downtimes, incompatible systems, data which is unintegrated and application development backlogs by information services groups. Even though the improvements in hardware and software technology have reduced the price of processing each unit of data, but the IT costs have increased in many business organizations when compared to other costs.

The generally listed factors which hamper the performance of Information Systems (IS) in an organization are:

- IT efforts are poorly prioritized.
- IS and non-IS executives fail to maintain interpersonal relationship.
- There is a lack of understanding or compatibility between IS and the business environment.
- IS fails to meet its commitments.
- Employees fail to understand that IS is a critical resource.
- IS falls short of achieving its predetermined goals.
- The management of IS lacks leadership skills.

#### 1.7 Project Planning

Project Planning occupies a prominent place in operational planning. It is a part of project management. In project planning, one makes use of schedules such as Gnatt charts to plan and afterwards report the progress within the project environment. Project planning takes into consideration the development of plans, procedures and schedules for an information systems development project.

In the first stage of project planning, the scope of the project is defined and the methods, tools and techniques for completing the project are shortlisted. After this step the time required for different tasks to complete the work is listed and grouped in the form of a structure which gives the breakdown of the work. The activity network diagram can be used to describe the logical dependency between various tasks. This diagram also gives us the shortest time duration of completing the entire task through a series of sub-tasks. The project plan may be optimized to strike a balance between the usage of resources and the time of completion of the project. This will now result in the project plan becoming a baseline. After this blueprint is ready, one can measure the actual progress with respect to the baseline all through the entire life of the project.

On the Personal Computer (PC), project management and personal information packages can be used to do task and project management. The applications and packages that help in this endeavor are Microsoft Project and Outlook, Lotous Organizer and CA-Super Project. Project management groupware helps project teams to work together and also assists team members to keep track of the many tasks and timelines involved. These tools produce project schedules, program reports, and automatic reminders of due dates for project tasks. Task and project management groupware also produces charts to help plan and track projects.

## 2. STRATEGIC INFORMATION SYSTEMS PLAN

Strategic Information Systems Plan (SISP) identifies the information systems and technologies required to support the business strategy identified in the strategic business plan. In SISP, business models are used to analyze the information and processes of a corporation and an evaluation of risk, current needs and requirements is undertaken. This results in the formulation of an action plan which shows the desired course of tasks which are necessary to align the strategic needs of business with information resources. SISP is a management function and not a technical function. This plan is a roadmap for Information Systems (IS) managers to decide on the type of information needed by the organization, sources of information, the compatibility of existing systems with the information gaps present with the existing systems so that the good decision-making is promoted in the organization. One of the important tasks of SISP is to identify emerging technologies which can be helpful in strengthening the competitive nature of the organization. The following are the four areas of influence of SISP. They are:

- i. **IS Investments:** The IS investments should be compatible with the business goals such that IS can become a driving force for achieving business goals.
- ii. **Cutting Edge IT:** The adoption of latest IT hardware and software would ensure organization's competitiveness in the national and international arena.
- iii. **Management of IS Resources:** In addition to adoption of innovative and cutting edge IT, it is also necessary to manage IS resources efficiently to achieve optimum results.
- iv. Policies and Practices for Developing and Adopting Technology: Policies and practices which are well-documented help IS managers to strike a balance between developing in-house technology and buying or adoption of technology and related products from the market.

SIS plan is needed by different levels of management team for the following purposes:

- SIS plan helps top management to develop core competencies and strategic directions with the help of Information Systems.
- SIS plan provides the middle and operational management team with the necessary tools that help them in making quick and informed decisions.
- SIS plan helps marketing and customer care department to provide improved after sales service.
- MIS department is able to integrate and manage the technological expectations of various functional areas of the business.

#### 2.1 Steps for the Development of SISP

The following are the steps involved in the development of SISP:

- i. Different organizations have different tasks and strategic needs. For instance, the needs of the police department may be different from a hospital in the matter of adoption of IS. Thus, the purpose of the plan must be decided initially and a broad outline must be developed regarding the specific problem, the plan should address.
- ii. The strategic business plan and the goals of the business must be updated. The current business environment must be analyzed and reassessed.
- iii. Currently available information systems including hardware, software and networking capabilities must be taken into account. This will help in forecasting the future information needs and systems.
- iv. New systems, projects and capabilities which are required to meet the changing environment and changing information needs must be identified.
- v. The amount and type of resources (like skilled IT personnel, amount of finance etc.) must be identified to implement the plan and proper backing for this plan must be secured from the top management.

## 2.2 Steps for Ensuring the Success of SISP

The following are the steps which are necessary for ensuring the success of SISP:

- i. The technology that is needed to implement IS must be compatible with the processes that drive the technology.
- ii. Strategic systems must ensure strategic alliances between trading partners.
- iii. Technological systems become obsolete in a very short time. Therefore, old systems must be improved or new investments must be ensured so that organization does not fall behind its competitors in the long run.
- iv. Organizational culture must encourage optimum level of risk-taking which is consistent with the returns that might be generated. Adoption of IS systems may involve some amount of risk in the short-term in the matter of financial resources or employee satisfaction and training. However, in the long run IT will get integrated with other functions of the organization.
- v. Even though organizations may adopt latest innovations in the field of information technology systems and communication, ultimately it is the employees who are responsible to manage them and derive benefits for themselves and for the organization. Therefore, to minimize resistance from the employees they have to be properly trained to use the strategic systems so that they may not find it difficult to use it.

#### 2.3 Advantages of SISP

The following are the advantages of SISP:

- i. SISP forms a link between the objectives of an enterprise and the resources needed for implementing IS in order to achieve those objectives.
- ii. SISP also forms a link between corporate objectives and the core competencies and competitive advantages of the corporate IS environment.
- iii. SISP helps in deriving competitive advantage with the help of IS.
- iv. SISP helps in bridging the communication gap between different departments of the organization.
- v. SISP improves the performance of the business processes so that they provide timely, accurate and consistent information to make decisions.
- vi. SISP identifies technology resources that are needed to carry out organizational changes.
- vii. SISP helps in making controlled and proportionate investments in PCs, networks, Internet/Intranet/Extranet and other emerging technologies.
- viii. SISP helps the organizations to adopt customer-focus approach rather than technology-focus approach.

#### 3. IMPLEMENTATION AND EVALUATION OF MIS

All over the world, MIS has been implemented in many organizations. However, a few organizations have achieved success in implementing MIS. The major reason for this is the organization's resistance to change. The behavior of employees in the organization leads to resistance in the path of the implementation of new processes. When a new technology is introduced in the organization, certain business processes are bound to be modified and/or replaced. Employees who are habituated to using the traditional business processes will generally be reluctant to change over to the new technology. The top management's lack of commitment to MIS implementation can also lead to resistance to changing over to the new system. If the employees are encouraged to actively involve themselves in the project, the problem of resistance to change can be overcome. The second reason for resistance to change is the technical problems in the system that can lead to resistance in the system. Resistance to change can also occur when the employees are not properly trained in the use of new technology. The success of the MIS can be ensured if the users are properly trained to handle and operate the new technology. For instance, it is necessary to use computers to reap the full benefits of the MIS. However, employees in an organization who are habituated to using the traditional means of operations have to be given sufficient training to enable them to operate the computer systems comfortably.

## 3.1 Approach to MIS Implementation

The MIS can be implemented in an organization in two different ways. In one of those methods, systems analysts are given more importance than the users of the MIS. The systems analysts make all the major decisions in the implementation process and the users merely respond to specific inquiries made by them. This method of implementation is commonly found in many organizations. The other method emphasizes the combined efforts of both systems analysts and the MIS users. MIS users actively participate in the implementation process along with systems analysts and as a problem-solving team, they are together responsible for the development of an effective and efficient MIS. In this type of implementation, both sides participate through mutual learning and criticism. Though the second method of implementation is found only occasionally, the chances of post-implementation success are high for this method as compared to the first method.

The change approach to MIS implementation can be seen in the second method of implementation. This approach mandates the active participation of MIS users and the top management during the implementation process. It emphasizes on creating

an environment where organizational change is accepted through the active involvement and education of organizational members (who are deemed to be affected the most) and through assigning the implementation responsibility to them.

Involvement refers to the active participation of organizational members in the implementation. The phrase organizational members include all the members of the organization who are directly or indirectly affected by the MIS implementation. They include the top management, all the functional managers, operating managers, operating staff, systems analysts, programmers, etc., concerned. Though active participation is mandated, the level of such participation from each group of members varies. Involvement in the implementation reduces the employee resistance to change (to the new processes and practices) to a large extent. To eliminate resistance altogether, all organizational members have to be educated about the benefits of management information systems at the organization level as well as at the individual level. Further, MIS users have to be trained in the new system and process in terms of operations and supervision. Educating the employees should start before they become a part of the implementation process. The employees have to be educated on the importance of the MIS to the organization and how it will, in turn, bring benefits to the employees. MIS users benefit the most from the implementation as they get handson experience in operating the system. Hence, employees have to be educated in light of the benefits associated with the implementation. This would help involve them actively in the implementation process.

If the employees are to be comfortable using the MIS on a regular basis, they have to be trained adequately. Training the employees during and after the implementation process fulfills these educational requirements. Training is given in both general as well as specific areas. The general areas of training include introduction to computers and information systems concepts; how the MIS provides connectivity to all the departments in the organization and how information flows to and from each department, and development of organizational members' interpersonal skills. The specific areas include information management in each functional area, technical details on operating the MIS in each functional area, etc.

The most crucial part in the MIS implementation efforts is the implementation process itself. The implementation process involves installing the MIS physically in the organization and training the users to adapt to the system. The implementation process includes planning, organizing, developing procedures, training the users, developing forms for data collection, developing files for storage of data, testing the system, cutover, and documenting the system.

The MIS implementation always starts with planning. Planning refers to the overall planning function relating to MIS installation. It includes broad, strategic planning and only the higher levels of management are involved in it. But the implementation planning is about how the MIS design can be transformed into a physical reality. It involves procurement of the necessary equipment (including hardware and software, installation of networks, documenting the system, running the system live, generating information files, training the employees, etc. Systems analysts and managers together develop the detailed plans, but the managers have the final say in them. An implementation plan has to cover all the tasks and subtasks in order to assign specific responsibilities to different organizational members. Broadly, an implementation plan has to identify and establish relationships among tasks, establish a schedule for the completion of all the tasks, prepare a cost estimate for the tasks, and establish a reporting and control system.

The project manager is often entrusted with the responsibility of implementing the MIS. In large organizations, the manager of the MIS is entrusted with this responsibility but in small organizations, the functional heads may take it up. Line managers must be entrusted with the responsibility for implementation and their

roles have to be clearly defined and explained to them. Middle level managers should be briefed by the top management about the duties of line managers so that they can assist them. Systems specialists will have to assist the managers in implementing the MIS. The management should strive to inculcate a sense of responsibility in all the staff members, including those involved in operating the system. Employees will resist change only when the need for change has not been properly communicated to them. If the management is able to involve the employees in the implementation of the system, they will welcome the system. The management generally employs specialists for the implementation of the MIS and as a result, employees feel isolated from the process and resist MIS implementation. It will be very difficult for the organizations to reap the full benefits of the MIS without the cooperation of employees.

## 3.2 Basic Requirement of MIS

Information Technology has made rapid inroads in almost all organizations of the world. In order to deal with enormous amount of data generated and to keep pace with dynamisms of business systems and technology, organizations have shown their preference for computer-based management information systems. Thus, the basic requirements for implementing a computer-based MIS are as follows:

- **Hardware:** It is a term which is used to refer to computer equipment and associated electronic and physical devices. The functions of hardware are input, output and storage of data and computer programs, central processing (computation, control and primary storage) and communication.
- **Software:** Software is a broad term. It is the set of instructions or programs that are used to control the operations of hardware and also to capture data and process it. The two types of software are system software and application software. System software deals with the specific instructions given to the computer and its associated devices in order to perform their tasks. Application software is the set of instructions with the help of which a specific task of the user is accomplished. For example, there are application software available to carry out numerical calculations involved in business transactions.
- **Database:** The application software operates on the data stored in the database to produce output or results. The physical existence of stored data is known as database. A database consists of a set of files. Each file contains records. For example, if we take employees of an organization, then each employee is assigned a record which contains his personal information like salary, date of birth, employee number etc. The records of different employees, put together constitute a file. A number of files put together constitute a database.
- **Procedures:** Procedures are in the form of instruction booklet or a manual which exist in physical form. The three major types of procedures are:
  - i. User instructions (for users of the application to record data, employ a terminal to enter, update or retrieve data).
  - ii. Instructions to the data handling personnel for the type of input that should be used for getting proper result.
  - iii. Instructions to the computer operating personnel for handling the computer.

#### 3.3 Structural Implementation of MIS

To implement MIS in an organization, we shall consider a structure of MIS as given below:

#### 3.3.1 STRUCTURE OF MIS

The following are the three forms in which the structure of MIS can be described.

i. **Functional Form:** In an organization, a number of functions are performed like marketing, production, finance, purchasing, technical and accounting. Each function has its own information system which caters to the needs of the managers of that functional area. However, each information system has the right to interface with other systems in order to share information.

- ii. MIS at Different Levels: Management can be viewed as structured into three hierarchical levels. They are: (a) The top level or the strategic level, (b) The middle level or the tactical level, and (c) The bottom level or the operational level. Thus, MIS caters to the needs of information at all the three levels.
  - The Top Level or the Strategic Level: At this level, MIS is concerned with determining, maintaining and supplying information required by top level management. Top management is involved in strategic decision-making. Examples of strategic decisions are: mergers and acquisitions, new product planning, capital investments, financial structuring, etc. Top management establishes the policies, plans and objectives of the company as well as a budget framework under which various departments operate. They require strategic information about external environment, technological developments and market for products. MIS has to secure such information from various internal and external sources. The plans, policies and objectives formulated at the top level are passed down to middle management where they are translated into specific revenue, cost and profit goals if the departments work under the concept of cost or profit center.
  - The Middle Level or the Tactical Level: At this level, MIS is concerned with information that is necessary to elaborate, clarify and operationalize organizational goals formulated by the top level management. Decisions are taken at this level to transform policies and programs into actions. The examples of decisions taken at this level are pricing of products and services, planning of capacity, budget preparation, purchasing contracts etc. Additional information supplied by MIS at this level helps in formulating norms and in translating strategies and policies into action programs.
  - The Operational Level: MIS at this level is concerned with providing information to regulate and coordinate the programs and operational plans to produce goods and services. At the operational level, inputs are converted into outputs i.e., goods and services are produced to meet the goals of sales target and profits. Most of the decisions taken at this level are routine and repetitive. The examples of such decisions are production scheduling, maintenance, re-ordering, credit approval, etc. The information at this level is routine and repetitive. The information regarding production and production schedules generated at this level is sent to the higher levels.
- iii. **Comprehensive Structure of MIS:** The structure of a MIS is known as comprehensive if it possesses the following characteristics:
  - It should be closely directed by management.
  - It should integrate various subsystems of the management.
  - It should avoid duplication and redundancy of data.
  - It should provide for the effective dissemination of information.
  - It should be capable of meeting the information requirements of managers working in different functional areas.

#### **3.3.2 FACTORS FACILITATING IMPLEMENTATION OF MIS**

MIS department caters to the information needs across various departments of the organization. In order to implement MIS in an organization successfully, a few factors are to be taken into account. They are as follows:

- i. Top management should be involved in the formulation and implementation of IT policy. This involves detailed discussions with management team regarding the benefits of computerization, information security and enumerating the goals of MIS department.
- ii. An expert Electronic Data Processing (EDP) manager needs to be recruited who can identify the areas where MIS finds its application and then designs the system to meet the information needs of managerial staff at various levels and also develop standards in the design of reports. Organizations should employ properly educated and trained IT staff having interdisciplinary knowledge of computer science, management and operations research.
- iii. The budget allocated to the MIS department should be utilized in a balanced way on hardware, software and other infrastructural facilities. Proper utilization of budget in all the functional aspects ensures optimum functioning of MIS department.
- iv. MIS department has to constantly look out for latest changes in the field of communications and technology. Implementing new technologies with sufficient pace enhances the information goals of the management.

### 3.4 Performance Evaluation

Once the MIS has been implemented, it has to be evaluated. Evaluation of the MIS is necessary to ascertain that the intended objectives of MIS implementation are met. One of the main objectives of the MIS is enhancing the ways in which the operations are carried out in the organization. Post-implementation evaluation can be used to confirm the extent to which the MIS is being used in the organization to enhance effectiveness and efficiency. Evaluation of the implementation also brings to light the efficiency with which the allocated resources are utilized in the process.

To evaluate the MIS implementation, it is necessary to understand the objectives of the organization and the information system. The strategic goals are the foundation for detailed operational goals. This hierarchy of goals has to be understood as a necessary precursor to the evaluation. MIS can be evaluated for the efficiency with which the allocated resources are utilized in the development/implementation and the effectiveness of its usage after the implementation. The objectives that can be considered to measure efficiency in the MIS implementation can be technical quality, scheduled completion, user participation, available man-hours, MIS personnel training, etc. The possible performance measures for these objectives can be compliance to systems development standards (for program design, database design, testing, etc.), compliance to the schedule and variances if any, amount of user involvement and type of user involvement, and expenditures incurred in MIS training.

Information technology and information systems are the major driving forces which have brought about sea change in the managerial capabilities and the organizational structure. Due to proliferation of various IT resources like the Internet, intranet, extranet, client-server networks, LANs, WANs etc., the computing and decision-making power of managers has increased manifold. In addition, the productivity of employees, the quality of goods and their volume, customer service and penetration of goods and services in every nook and corner of the world is the direct or indirect result of the growth in information

#### Planning, Implementation, Evaluation and Maintenance of MIS

technology and systems. Thus, it has become imperative for all the organizations in various sectors to adopt IT and information systems in varying degrees. It is not an exaggeration to say that the larger the role of IT in the organization, the more competitive the firm will be in the industry. For example, the support provided by information systems technology in the field of decision-making has helped managers to focus their attention on complex strategic policy questions in order to develop realistic alternatives for the present dynamic competitive environment instead of getting involved in the computational procedure involving quantitative data.

The evaluation of the system brings to light proposed benefits from the new system which were pointed out during the project initiation stage. System evaluation is also a postmortem exercise in order to compare the actual benefits that are realized with the benefits that were planned for. Following are the criteria for evaluation of the system:

- i. **Availability:** The probability that the system will be ready for operation when called upon.
- ii. **Dependability:** The probability that the system completes the task assigned to it satisfactorily.
- iii. Capability: The potential of the system to achieve its objectives.
- iv. **System Integrity:** This determines the way subsystems are integrated without giving any scope to redundancy. It also measures the flexibility of the system and its enlargement.
- v. **Operating Integrity:** This determines the skill set of the people operating the system. The alternative measures need to be implemented in the event the system crashes or key personnel manning the system leave the organization.
- vi. **Procedural Integrity:** The documentation part of the system procedures and the employees who are motivated to follow all the procedures.
- vii. **Internal Integrity:** The efficiency of the system and its effectiveness in completing the tasks for which it is being commissioned and also the quality of the output that it produces.

It is easy for companies to become part of the digital revolution by adopting IT and various information resources because they are readily available to carry out almost all the business activities and functions, but it is a daunting task for companies to mange IT and related resources to meet the challenges of today's dynamic business and technology environment. This is because there is a problem of plenty i.e., a vast variety of information resources, networks, technologies and applications are available from a number of vendors and it is a difficult task to choose and implement a computerized system that gives efficient, economic and satisfying results. As we have discussed earlier, planning is very important at different stages of procuring, implementing, installing and using IT and information systems. Planning helps to benchmark the performance of information systems and compare the actual performance with the standard performance.

## 3.5 Challenges in MIS Implementation

The implementation of an MIS can be a traumatic experience. At minimum procedures will impact the ways in which plans are made, programs are developed and performance is evaluated within the organization. Efforts to improve the MIS may also uncover the need for organizational changes, which may be even more unsettling than the changes required for implementing the system.

The installation of a new system is a political process. It involves pressure, persuasion and compromise as in the case of any important political action. Operating managers are more likely to support the system if they are convinced that it will help them function better and carry out their responsibilities. The new

system should provide operating managers with better information about the activities and performance of those staff members for whom they are responsible. With this information, the operating managers can have a better basis for directing and controlling the efforts of subordinates. It may not be feasible to install an MIS across the whole organization all at once. Organizations may concentrate initially on those departments in which the results of improvement will be most visible. Success in one department can lower resistance and increase acceptance throughout the organization. It is difficult to accurately estimate the time period required to successfully design and implement an MIS. In large organizations, it may take two or three years to decide, initiate, and implement a new system.

## **4. MAINTENANCE OF MIS**

Along with implementation, it is also necessary to give attention to the maintenance aspects of MIS in an organization.

System maintenance involves refining the system so that it is able to meet the changing requirements of the business. A large amount of money and effort is involved towards system maintenance than that needed for initial development of the system because the system continues to change and evolve as it is being continuously used. Project manager is responsible for maintenance of the system. Following are the reasons that necessitate system maintenance:

- i. **Bugs in the System:** When MIS is initially developed, it may not be possible to detect and report any bugs. However, with the usage of the system over a period of time bugs appear on the scene that may cause major problems and irritation to the users. Corrective maintenance is needed to restore the confidence of the users.
- ii. **Enhancement to the System:** MIS needs to be periodically enhanced to add any additional features that are necessary. The use of the system by the users brings to light any minor changes in the design that can make the system more productive and also bring to light any additional functions that it can perform. This is known as perfective maintenance.
- iii. **Integration of Systems:** Due to the technological developments, new types of information systems are coming into being. Maintenance is also needed to integrate new systems.
- iv. Software and Network Changes: The software must be maintained in order to ensure that the performance and reliability of the system is up to the mark. It is also necessary to reduce the complexity of the software over the period of time through refinement and incorporating new technologies.
- v. **Strategic Changes:** System maintenance is also needed to incorporate major changes in the organization's strategy and operational policies.

## 4.1 Prerequisites for Effective Maintenance of MIS

The most important prerequisites of an effective MIS are its resources and support from top management. These aspects are discussed below:

- i. **Trained and Qualified Systems and Management Personal:** For effective implementation and maintenance of MIS, trained and qualified personnel at all levels should be present to manage it successfully and produce desired results compatible with the goals of the organization. There are basically two types of personnel working in MIS department. They are: System, Communication and computer experts and Management experts.
  - System, Communication and Computer Experts: These experts should be capable of understanding the management concepts and problems so that they can provide technical solutions. They should also have proper understanding of decision-making and information requirements at various levels of management such that they can design the technical specifications of MIS which can meet the planning and control functions of the management. The experts in this area should also monitor the security, privacy authorization and access controls of the system.

- Management Experts: These experts should have basic knowledge and understanding of the computer systems. They should know the requirements of the organization that MIS has to satisfy so that they can hire the technical experts so as to implement the goals of MIS. Management experts should understand the availability of MIS personnel in the job market and design proper compensation policies to hire the best personnel in the field. The management should also take into consideration the need of third category of personnel who are very important. These personnel are the users of the system.
- ii. **Database:** The word 'database' refers to the collection of large number of files. The data is stored in the files in the form of records. The data or the records can be accessed from a particular file by the users. The word database is now replaced with a comprehensive term known as Data warehouse. The important features of databases are:
  - Avoiding Uncontrolled Data Redundancy and Inconsistency: The data stored in a database can be accessed by a number of application programs. The data is stored at only one place. Thus, each application need not store the same data separately. This arrangement avoids storage costs and multiplicity of the same data in different files.
  - Independence of Data and Program: In Database Management System (DBMS), programs written to access the data are independent of the actual physical layout of the data and the logical structure of the data. DBMS provides a means to map the logical view of the data given in the application to the actual physical layout of the data stored on the storage devices.
  - Access to Shared Data: Query languages enable the users to access only that part of the data that satisfies their queries. Application programs can be written to access the stored data in a corporate database. A number of users can simultaneously use their application programs to access data from the database.
  - **Reliability:** DBMS ensures the reliability of the stored data in the databases. With the help of DBMS, different relationships between entities may be defined.
  - Centralized Control of Data: Since all the data is stored at a central location, the consistency of data resources and global planning can be ensured in an easy way. Security features and authorization controls can be incorporated and monitored in an effective way. It is difficult to put security devices at a number of places if the data is stored at multiple locations. However, international standards of storage and maintenance of corporate databases must be followed.
- iii. **Support from Top Management:** The top management should realize the benefits of MIS and ensure their wholehearted support for the implementation and use of MIS in the organization. They should recruit proper personnel for the MIS department, make necessary budgetary allocations, specify the requirements of the organizations in an unambiguous way to the MIS experts and ensure that the staff concerned are properly trained to make effective use of MIS in discharging their official duties.
- iv. **Control and Maintenance of MIS:** Management at each level should ensure that the MIS is being used in accordance with the rules laid down by all the employees concerned. The users should be allowed neither to develop their

own procedures to access data nor to cross the limits of privacy and security. The upgradation and improvement of MIS should be undertaken in a periodic manner so as to meet the changing needs of the environment. The documentation concerning the input data, output data, methods, procedures should be circulated among the users.

v. Evaluation of MIS: After installing MIS, it is essential to evaluate it in order to see to it that it is able to meet the user requirements. Timely action should be taken to correct any deficiencies in the system. MIS should be flexible to take into account any changes. The opinion of the users should be solicited from time to time and proper adjustments should be made for smooth functioning of the system. Authorities should be taken into confidence before implementing any changes to the system.

## 4.2 Role of Management in Maintenance

The role of managerial personnel is very important in the maintenance of MIS in an organization. Their involvement would solve the problem of poor performance of information to a large extent. While managers should be involved in the administrative governance of IS function, the end-users should be involved in the development of IS applications. The organizational structure should be revamped so as to encourage active participation of managers in the planning and control of business uses of IT. Policies and procedures give clear picture to the managers regarding their involvement in the decision-making process pertaining to the effect of IT on their business units. Thus, to improve the performance of information systems, there should be involvement of business managers at different levels in the governance of information system. Figure 2 shows the levels of management involvement in IS governance.





From the figure 2, the major management levels involved in the governance of IS are:

i. **Executive IT Committee:** The top executives form an executive information technology committee to devise strategic information system plan and to coordinate the development of major information systems projects. The top executives include senior managerial staff of major divisions of the firm and the Chief Information Officer (CIO). CIO is the executive who governs the IS function and is the head of IS department in the organization.
- ii. **IT Steering Committee:** A steering committee comprising business unit managers, operating managers and management personnel from the information services department is formed to oversee the progress of vital systems development projects. Meetings are conducted by the committee on a regular basis to review progress made, to settle disputes and to reshuffle priorities if any need arises.
- iii. End-user Management: Responsibility also lies with end-user managers for managing the resources and quality of information systems and services coming under the purview of their business units and workgroups. They have to involve themselves in IS development projects that affect their business units, as well as managing the people, hardware, software, network and data resources within their units.

# 5. ADVANTAGES AND DISADVANTAGES OF MIS

# 5.1 Advantages of MIS

Following are the advantages of MIS:

- i. **Meeting Global Challenges:** Due to the technological innovations, the world has become a global village. The wave of liberalization and globalization has swept the entire world. Many countries of the world have signed free trade agreements either multilaterally or bilaterally with other countries. Thus, business organizations are now free to do business (i.e. export or import goods) in any part of the globe. Thus, the competition has increased many folds. To expand its market share and also to penetrate new area and new businesses, companies must effectively coordinate and control products, people and procedures globally. Technologically-based superior information i.e., timely, accurate and reliable will go a long way in establishing the supremacy of multinational business organizations.
- ii. Enhancing and Developing Corporate Strategy: The organizational structures of multinational companies are very large. Their branches and subsidiaries are spread in different countries, but the headquarters of these companies are located in a particular country from where the top management team takes decisions for all their units spread across the world. They have to deal with different cultures, people, governments and laws, products, types of competitive forces, etc. Thus, information systems and computers play an important role in helping them to take decisions and make economic predictions that would in turn help in framing policy decisions.
- iii. Enhancing Workers' Productivity: Information technology plays an important part in training employees of an organization. In the dynamic business environment, technology enhances the pace of learning. Different modules of teaching material can be made available at the desk of the employees with the help of laptop computers and Internet. In addition, there are technologies like electronic learning, mobile learning with the help of which study material can be made available at any place and twenty four hours a day. In addition, application programs are available which can track customers, evaluate the performance of the employees, generate payroll and order raw materials to replenish inventory.
- iv. **Improving the Quality of Goods and Services:** Due to increase in competition, companies manufacture goods which adhere to the quality standards because such goods are only valued by the customers. The most popular approach to produce high quality goods and services is the Total Quality Management (TQM). To enhance the quality of goods and services, companies need a lot of scientific and technology-related information. That

information has to be disseminated to the right people at the right time. There must be coordination among various departments and units of the company spread across the globe to arrive at quality control decisions. Information systems and computers not only provide computational support for achieving quality standards, but also help in creating awareness among the employees.

- v. Integrating Departments with Different Functions: For the organization to be successful, different departments have to coordinate their efforts to achieve synergy. A lot of data and information has to be exchanged between different departments in a very short period of time. Information systems can bring different functioning units together by linking their tasks and functions.
- vi. **Discovering and Utilizing Opportunities at the Marketplace:** There is a proverb which says that "Time and Tide wait for none". Opportunities come and go. Only those companies are successful which have expertise in discovering and utilizing business opportunities even before their competitors' can get a wind of it. Information systems have the capability to perform complex computations on given data and provide clues to the management of the inherent opportunities in the market. Strategic Information Systems (SIS) are those which can identify strategic growth opportunities in the marketplace. For example, by carefully collecting data related to buying and selling habits of customers in urban or rural areas and performing appropriate mathematical and statistical operations, credit card companies can predict the volume of sales that can be achieved for different kinds of credit cards.

## 5.2 Limitations of MIS

- i. MIS provides output in the form of information to the managers. But the quality of data or the processes should be of very high standard in order to produce output which can help managers in making appropriate decisions. MIS cannot be expected to give exceptional results of high quality, riding on inferior quality of input or data.
- ii. MIS can only assist managers by providing the required information. It can neither take decisions nor implement decisions. Acting on the information at their disposal, it is only the managers who have to take appropriate decisions and implement them. Managers also need to take the internal and external environment of the business into consideration before implementing the decisions.
- iii. In the fast changing complex business environment driven by technology, MIS may not have the required flexibility to quickly update itself.
- iv. Even though MIS can provide information to managers, it cannot provide tailor-made information to assist the decision-making process in varying and unique circumstances. It is not possible to generate information packages which can assist in every conceivable situation.
- v. MIS takes into account only the quantitative factors. It cannot provide subjective judgment on the matters like individual morale, attitudes of members of the organization, motivation levels of the members, etc.
- vi. MIS has very little applications in the matter of non-programmed decisions. There are certain problems and situations wherein predetermined solutions are not available. These problems are unique in nature, which have not surfaced on previous occasions. Thus, decision-making in such situations is difficult because the outcome of such decisions is not known before hand. Managers have to use their intuition to arrive at decisions.

- vii. Implementation of MIS requires information to be made available without any bias. In organizations where there are personal prejudices, hoarding of information and rampant intra-organizational conflicts, MIS will not gain due recognition.
- viii. MIS requires wholehearted support from top-level management. Frequent changes in the hierarchical structure of the management will decrease in the effectiveness of MIS.

# 5.3 Constraints in Operating MIS Department

Following are the constraints which organizations face in operating a MIS department:

- i. When proper experts are not available, it is not possible to examine the objectives of the organization and design a proper path for implementing fully operational MIS.
- ii. Experts usually face challenges in selection, design and operation of those subsystems of MIS that are to be operated in the initial phase.
- iii. Management faces the difficulty in locating and hiring experts with effective MIS skills.
- iv. For the experts there is no standard method or design of MIS that they can implement because the business environment and the circumstances faced by each organization is different. One model of MIS is different from that of the other.
- v. The staff of MIS department may not receive adequate cooperation from the staff of other departments due to ignorance or computer illiteracy.
- vi. Inadequate financial resources or budget allocation may hamper the operations of MIS department.
- vii. Due to the boom witnessed in the field of Information Technology (IT) and rapid changes in the field of IT, job hopping by the experts creates problems in running the department.
- viii. MIS is a service-oriented department. Therefore, it is difficult to quantify its benefits in monetary terms unlike other departments, for instance, the production department. Hence, it is difficult to compare the costs incurred and the benefits derived for this department. The utility of MIS is not easily perceived by the members of the organization. Also, statistical or mathematical representations of data made available to the management are only indicative parameters and not true representations for decision-making.

# 5.4 Myths about MIS

Following are the myths or misconceptions about MIS:

- i. Most people think that the study of MIS is the study of computers which is not true. Computer is only a tool in the implementation process of MIS. There may be MIS which is not based on computer systems. The use of computers in MIS helps in reducing the time of processing data and numerical computations.
- ii. It is not true that a large number of reports produced by MIS are very effective in serving the cause of the managers. For managers, it is not the quantity of data but the quality of data that is very important. The information should be timely, accurate and precise because it is not possible for managers to go through volumes of data and take decisions because of the dynamic nature of the complex business systems.

iii. It is also not true that accuracy is very important in the reports. Accuracy finds its importance in those reports generated for the operational level managers. Higher levels of accuracy involve greater amount of financial resources. At the higher levels of management, data concerned with broad objectives, external and internal environment and emerging opportunities for achieving the mission of the organization is very important. That data is important which gives a snapshot of the global environment of the business.

# 5.5 MIS in Indian Organizations

The importance of MIS has been well-realized in developed countries like the US. Though India is regarded as a leader in the field of information technology, Indian organizations are lagging behind in realizing the benefits of MIS in technological and industrial development. Industrialists have been reluctant to consider the benefits of MIS. Therefore, the traditional way of thinking and reluctance on the part of management to support the implementation of MIS has resulted in Indian organizations lagging behind in the field of information management in the competitive international markets. Thus, the success achieved in the field of MIS is limited. The lack of infrastructural facilities and the reluctance towards budget allocation for establishment of MIS department are the other hindrances. Also, Indian managers refuse to accept tools that store financial accounts of the company that would reveal facts not projected by companies in the public domain. There is also a shortage of trained personnel to handle the MIS department. The reason for this is that there are no specialized educational courses in the field of MIS at the university level. There are very few multinational companies of Indian origin. Their size is very small when compared to the multinational companies of the developed countries. Therefore, Indian companies cannot achieve economies of scale by starting MIS departments.

The government can come forward to encourage Indian companies to effectively implement MIS by adopting the latest technology. The government can help by improving infrastructural facilities in the field of power generation, bandwidth connectivity etc. It can also provide tax incentives for the companies in their initial years of development which will help them to bear the cost of MIS. MIS can help Indian companies to tap international export markets. There is a lot of demand for cheap and innovative traditional goods and services of India in the international markets. Lack of timely information and slow processing of data is driving away the business opportunities of Indian companies towards their competitors. MIS can provide valuable information to the Indian companies to explore unknown markets and bring in the much needed foreign exchange to the country. New technologies like Internet technologies, data mining, electronic data interchange, electronic commerce, smart cards, computing based on biometric devices, mobile commerce can help Indian companies to increase the scope and use of MIS in their organizations.

In India and the world over, the growth of MIS is due to the introduction of computers in the field of information management. In India, computers are widely used in generating databases and processing data for government departments like transport and health, sales tax collection, employment exchange, police computer centers, telephone and electricity billing departments etc. The information systems and MIS have greatly benefited different organizations. For instance, criminal records and databases have helped police personnel to match the fingerprints taken from the scene of crime with the central database of the criminals designed and compiled with the help of data collected from the entire country. Thus, police personnel can coordinate with their counterparts in other regions or provinces in the matter of criminal investigation within a very short period of time. The banking sector has also greatly benefited due to the generation of computerized databases of customers. Thus, the information systems have helped banks to analyze the customer's loan repayment and credit card usage trends. This helps banks to design their policies in a better way.

#### Planning, Implementation, Evaluation and Maintenance of MIS

In addition to service organizations, manufacturing industries are also taking up computerization of their information systems. Their awareness about the importance of computers and its applications in various fields including MIS has grown due to easily available literature that is churning out information relating to the technological innovations in the field of IT. The software industry in India has seen phenomenal growth in the last decade and has been commended by the entire world. This has helped in automation of industries by developing application programs to carryout technical and manual tasks. The hardware sector and the electronics industry are also growing at a reasonable rate, even though their growth is less when compared to the software and IT-related services industry.

Technology is the driving force for the growth of MIS all over the world. IT plays a major role in the creation of knowledge, processing of data, producing high quality information and transmission of information across various locations of a company all over the world. Various business application software that help managers to take decisions and implement them are also the result of technology. In India, due to high cost of capital, inadequate infrastructural facilities and dependence on foreign countries for technology, small businesses face maximum difficulty in obtaining infrastructural services related to information system such as telephones, facsimile machines (fax), computers, network connections, telecommunications equipment, etc.

MIS in Indian organizations, both in public and private sector is still in its infancy when compared to developed countries of the world. This is largely due to uneconomical prices of electronic components, inadequate training and education, poor infrastructural facilities like power shortages, bad conditions of the roads, etc. Cultural factors, illiteracy, unbalanced growth in rural and urban areas and poor telecommunication infrastructure undermine the development of MIS. Internet and computer users in India are negligible when compared to the neighboring countries in South-East Asia. The labor unions are reluctant towards computerization for the fear of job loses, even though the evolution of software industry has given rise to many jobs.

## SUMMARY

- Planning is one of the management functions and it is the forerunner of implementation stage. The result of organizational planning process is called a plan. Plan develops a blueprint of actions which are necessary to achieve a goal.
- Strategic planning deals with the development of an organization's mission, goals, strategies and policies. Strategic planning is the task of top management. The top management takes into account mainly the external environment of business and formulates strategic plan after undertaking SWOT (Strength, Weakness, Opportunities and Threats) analysis.
- Strategic Information Systems Plan (SISP) identifies the information systems and technologies required to support the business strategy identified in the strategic business plan. In SISP, business models are used to analyze the information and processes of a corporation and an evaluation of risk, current needs and requirements is undertaken.
- Information Technology has made rapid inroads in almost all organizations of the world. In order to deal with enormous amount of data generated and to keep pace with dynamisms of business systems and technology, organizations have shown their preference for computer-based management information systems.

- In project planning, one makes use of schedules such as Gnatt charts to plan and afterwards reports the progress within the project environment. Project planning takes into consideration the development of plans, procedures and schedules for an information systems development project.
- The basic requirements for implementing a computer-based MIS are hardware, software, database and procedures.
- Procedures are in the form of instruction booklet or a manual which exist in physical form. The three major types of procedures are:
  - i. User instructions (for users of the application to record data, employ a terminal to enter, update or retrieve data).
  - ii. Instructions to the data handling personnel for the type of input that should be used for getting proper result.
  - iii. Instructions to the computer operating personnel for handling the computer.
- For effective implementation and maintenance of MIS, trained and qualified personnel at all levels should be present to manage it successfully and produce desired results compatible with the goals of the organization.
- The role of managerial personnel is very important in the maintenance of MIS in an organization. Their involvement would solve the problem of poor performance of information to a large extent.
- The advantages of MIS include its assistance in meeting global challenges, in the development of corporate strategy, enhancement in workers' productivity, improvement in the quality of goods and services, integration of departments carrying out different functions, discovering and utilizing opportunities that arise in the market place.
- The limitations of MIS are that the output of MIS depends on the quality of data and processes, the fact that MIS cannot take its own decisions, the inflexibility of MIS, the heavy reliance of MIS on quantitative data ignoring subjective judgment and the implementation of MIS being dependent on the support of top managerial personnel.
- Indian organizations are lagging behind in realizing the benefits of MIS in technological and industrial development. The traditional way of thinking and reluctance on the part of management to support the implementation of MIS has resulted in Indian organizations lagging behind in the field of information management in the competitive international markets.

# **Chapter IV**

# **Management Control Systems and Managerial Controls**

# After reading this chapter, you will be conversant with:

- Introduction to Management Control Systems
- Designing the Control Process and Managerial Controls
- Budget as an Instrument of Control
- Variance Analysis for Control Actions
- Key Variables and Performance Measures

A Management Control System is a plan for the procurement of resources and their use in an efficient and effective manner in order to reach the goals set for an organization. It assists the management in the synchronization of the activities of the organization and steering them in a proper direction so that the organization is able to move along the developmental path. It involves functions such as planning, coordinating, communicating, evaluating and influencing. It helps in planning the activities of an organization and further synchronizes the activities. It communicates information to the different levels of the hierarchical structure. Further, it evaluates the information and would decide on the action to be taken. It influences people to change their behavior.

During the planning stage, the management of an organization decides on the activities to be undertaken and a management control system ensures that the management adopts the right strategies in order for the organization to achieve its goals and objectives. Management control systems foresee future conditions and are self-regulating in nature. They help the management in taking better and well-timed decisions.

## **1. INTRODUCTION TO MANAGEMENT CONTROL SYSTEMS**

The role of a management is to plan, organize and integrate organizational activities for the achievement of organizational objectives. This role is facilitated through management control systems. Methods and procedures play an important role in the exercise of management control. Management control encompasses planning, organizing, directing, and controlling program operations. It is implemented by means of performance indicators, budgets and budgetary controls, credit control, working procedures, inventory control, production processes and quality measures and other instruments so as to regulate organizational operations in a systematic manner. Internal controls are a subset of management controls that are needed to assure that there is no unauthorized acquisition, use, or disposition of the assets of an organization.

A control system is a set of formal and informal systems to assist the management in steering the organization and its employees towards its goals. Establishing a control system in an environment where there is distribution of accountability, reengineered processes, and local autonomy is a challenging task. A management control system is a set of interrelated communication structures that facilitates the processing of information for the purpose of assisting managers in coordinating the parts and attaining the purpose of an organization on a continuous basis. Control systems that are employed in all organizations are concerned with the work of coordination, resource allocation, motivation and performance measurement. A control system brings unity in the diverse activities of an organization.

**Definition:** The generally accepted definition of management control as given by Anthony and Dearden (1977) is as follows:

"Management control is the process by which managers assure that the resources are obtained and used efficiently and effectively in the accomplishment of the organization's goals".

## **1.1 Characteristics of Management Control**

The important characteristics of management control are:

- There is a focus on programs and responsibility centers.
- It is a total system that takes into account all the matters related to a firm's operation.
- Its framework is decided around a financial and accounting structure.
- Management control is exercised on the basis of two types of information. They are, the planned data, examples of which are budgets, standards and projections and the second one is the actual data.

- Management control consists of a set of actions such as programming, budgeting, accounting, analyzing, monitoring, evaluating and reporting the performance of individual heads of sub-divisions or units in an organization.
- Management control as the name suggests is the control exercised by top management personnel in private sector while decision makers appointed by the government exercise control in the public sector.
- Management control focuses its attention on the performance of the managers rather than on the organization as a whole.
- Management control takes into account both the efficiency and effectiveness while judging the performance of managers.

Management control systems ensure the synchronization of the activities of an organization and guiding them in the proper direction towards its goals and objectives. A control system is a set of formal and informal systems.

- **Formal Control Systems:** As the name suggests, there is a clear definition of the explicit structure, policies and procedures that the members of an organization need to follow. At the same time, they need to focus upon the needs of the customers and markets. Formal controls are laid out in writing by the management, whereas informal controls arise as a result of employees' behavior. Examples of formal controls are plans, budgets, regulations and quotas. Informal controls include group norms and organizational culture. Formal controls are framed by the managers, whereas informal controls often originate with employees and are affected by general socio-cultural factors. A formal control system consists of subsystems such as management style and culture of the organization, infrastructure, rewards, coordination and integration, and control process. The formal control process has two dimensions: formal planning process and formal reporting process. The formal control process has two dimensions – formal planning and formal reporting.
  - **Formal Planning Process:** The formal planning process has two dimensions: strategic planning and operations planning. In most organizations there are two budgets one for operations and one for strategies; and, there are two sets of reports one for strategic projects and one for operating activities. The formal planning and control process should support the style and culture of the organization, and should be supported by the infrastructure, the rewards, and the communication system of the organization. A strategic planning system is necessary to assist the organization in the planning and control of projects. It helps the organization to decide its goals and objectives, and key strategies. An operational planning system undertakes activities that are short-term in nature.
  - Formal Reporting Process: Detailed reports help the organization to assess the progress of its strategic and operational planning. Monthly, quarterly or yearly reports help the organization to analyze its performance periodically, and to decide on the next set of programs to be undertaken. Although planning and reporting appear to be two distinct processes, there should be a certain degree of integration. Strategic programs are born out of current operations and they grow out of current activities. Further, strategic plans and programs have a great impact on current operations and hence, these strategic plans should be adjusted from time to time in line with their effect on operations.
- Informal Control Systems: At an informal level every organization exercises control on its members by means of interpersonal relationships. Every organization has an informal dimension consisting of interpersonal relationships that are not shown on the formal organizational chart. Chester Barnard defines the informal organization as "the aggregate of personal contacts and interactions and the associated groupings of people". Informal

control systems promote greater compatibility and encourage the desire of the members to serve the organization to the best of their capabilities. Like formal control systems, an informal control system contains the subsystems such as recognition and rewards, informal coordinating mechanisms, style and culture and informal control processes. Informal management control occurs through meetings, conversation, site visits, etc. For instance, staff retreat and informal dinner serve in a small way the purpose of management control. The informal control process consists of activities engaged in by members of the organization outside of the formal control process, when dealing with non-routine decision making such as realignment of goals. Recognition and rewards are based on the performance of the individual. The informal coordinating mechanisms are the networks of relationships that emerge as a result of socialization and mutual adjustment by the employees. Style and culture refer to the prevailing style of management and the principal values of the organization.

Informal control systems increase the organization's ability to make adaptive responses. They support the management in adapting and maintaining the organization. More specifically, informal control systems help the organization to adapt itself to the environmental change and technical innovation. Informal actions in an organization include gathering information, showing appreciation, and enabling the easy flow of information through all the hierarchical levels of the organization. It shortens the communication channels. However, the management must rely upon certain formal systems to prevent instability within the units. There is a great emphasis on informal control system wherein the management would like to have employees who are loyal to the organization appointed in key positions. Informal management control is present in every organization irrespective of the presence or absence of formal management control.

## **1.2 Purpose of Management Control Systems**

The purpose of a management control system is to assist the management in the coordination of the activities of the organization and in steering those activities towards the achievement of the firm's overall purposes, goals and objectives. The purpose of the control system is to maintain that desired state. Information about the actual state of the organization is compared with the desired state, and if there is a significant difference, action is taken.

Control systems in an organization involve the following functions:

- i. Planning the activities of an organization.
- ii. Coordinating the activities of an organization.
- iii. Communicating information to different levels of the hierarchical structure.
- iv. Evaluating the information and deciding the action to be taken.
- v. Influencing people to change their behavior.

In the planning stage, the management of an organization decides the activities that an organization should undertake. The control process compares actual accomplishments with the set plans. Another important purpose of the control system is to ensure that the work of each part of the organization is in harmony with that of the other. Control systems are designed to bring about unity of purpose in an organization through the efforts of individuals.

The purpose of management control is to ensure that the right strategies are carried out to attain the organization's goals. Management control systems anticipate future conditions. They are not self-regulating in nature. Managers usually operate in situations of uncertainty and the control systems ensure that proper actions are taken whenever needed in spite of the uncertainty. Management control systems help the management in decision-making. In the management control process, decisions are made according to procedures and timetables.

# 1.3 Domain of Management Control Systems

According to Anthony, Dearden and Govindarajan, the implementation of strategy comes in the domain of management control systems. They consider strategic planning, management control and task control as three interrelated processes of planning and control. They view management control as a "process by which managers influence other members of the organization to implement the organization's strategies."

However, William Newman views that control is one of the basic phases of managing, along with planning, organizing and leading. He considers control to be an essential part of the management process and a part of all the managerial efforts of an organization.

New advances of cybernetics have brought about changes in the way the domain of control systems is viewed. The very word "control" means different things to different people. Katz, Kahn and Griesinger view the entire organization as a control system. Control is seen as a characteristic of a control system. Purpose and the attainment of purpose are central to the work of control systems.

Maciarello and Kirby consider the control of strategy and the control of operations to be a part of managerial control. It includes some aspects of the planning, organizing and leading functions of management. It differs from one organization to the other. Whatever may be the domain of the control system, it should be consistent with management practice. The control systems should accelerate the productivity and emphasize on quality improvements.

To summarize, the domain of management control systems includes the following:

- i. Strategic planning,
- ii. Management control,
- iii. Task control,
- iv. Control of strategy, and
- v. Control of operations.

## 1.4 Subsystems and Components of Control Systems

The subsystems and components of control systems include style and culture, formal and informal control processes, infrasturucture, rewards and co-ordination and integration mechanisams.

- i. **Style and Culture:** A control system should support the current style of the top management. Corporate culture contains shared value, common perceptions and the decision foundations applied by the people in the organization to the activities and problems of the organization.
  - *Corporate culture as a control mechanism:* The common beliefs and values shared by people in an organization about its activities facilitate control by developing a sense of group loyalty and reducing conflict and friction.
  - *Management indoctrination and skill training:* Indoctrination and training are intended to impart a set of attitudes and skills to assist personnel in carrying out the control process of the organization.
- ii. **Formal Control Process:** The formal control process has two dimensions such as formal planning process and formal reporting process.
  - *Formal Planning Process:* It has two dimensions namely, strategic planning and operations planning.
  - *Formal Reporting Process:* Detailed reports help the organization to assess the progress of its strategic and operational planning.

- iii. **Infrastructure:** The infrastructure of an organization refers to its structure and the patterns of its autonomy. Patterns of autonomy include levels of responsibility involved and the methods of measuring the tasks completed.
- iv. **Rewards:** An executive will have to persuade individuals to participate in the various activities of the organization and the best method to do so is to use an apt incentive program.
- Coordination and Integration Mechanisms: Organizations need specific vehicles for communication which helps in coordination, decision-making, conflict resolution and development of commitment and trust among the employees.
- vi. **Informal Control Process:** These processes are formed as a result of interaction between people. An informal control process helps in the development of new goals and objectives.

#### 1.5 Organizational Disasters and Management Control

Organizations have to learn to adapt to changed circumstances which may be due to factors external to the organization as well as those which are internal. It is almost impossible for organizations to predict disasters but steps can be taken to minimize the chances of their occurrence. Internal factors like resignation of managers, strikes etc., that may lead to disasters, are easier to deal with, but external factors such as natural calamities are not in the control of an organization.

Whenever a disaster strikes an organization, all resources have to be diverted to meet the situation. Panic grips in the organization when the organization and the normal communication system get affected. It is the duty of the top management to deal with the disasters and convince managers and employees of its ability to overcome hardships. Organizations can avoid disasters by developing a framework. The framework should be able to forecast disaster and the organization should be prepared to face it. However, the organization can work out plans that will help in minimizing losses in terms of life and property. After the disaster has occurred it is necessary to estimate the damage and monitor relief operations. There may not be any systematic effort by a particular organization that is struck by disaster, to estimate the damage done by the disaster. Qualitative reports are provided to the top management about the disaster and the causes responsible for its occurrence. The report also indicates the long term steps taken by the management to avoid the occurrence of disaster in future. Organizations can avoid disasters by developing a framework. The framework should forecast disaster and the organization should be prepared to face it.

## 2. DESIGN OF MANAGEMENT CONTROL SYSTEM

A management control system is a set of interrelated communication structures that facilitate processing of information and coordination between different parts of an organization. Control systems help in the effective implementation of an organization's strategy. The subsystems and components of management control systems should be mutually supportive so that organizational goals can be achieved. When the subsystems are properly designed, they provide a basis for an organizational control system. The control systems should be designed in such a way that they reflect the goals and strategies of the organization and also contribute to the effective implementation of the organization's strategies.

The following are the considerations which generally govern the design and implementation of management control system in an organization.

i. **Responsibilities of Top Management:** There is little doubt that the onus lies on the top management in the design and implementation of a management control system. This is because the decision on the goals, objectives, strategy and structure of an organization is taken by the top management within the organizational and environmental constraints. The finance manager assists the management in the design of the management control system.

- ii. **Organization Specific:** It is necessary that the design and implementation of the management control system is precisely oriented towards the organization and the situational context. Thus, the relevant internal and external environment of an organization must be taken into account before embarking on the design of the management control system. This calls for a through understanding of the nature of the business-whether it is a service organization, a manufacturing organization, a profit-oriented organization or a non-profit oriented organization, the size of the organization, its technological requirements, etc.
- iii. Goal Congruence: The management aims at efficient and effective achievement of goals. Management control system is basically designed for that purpose only. Each responsibility and profit center must aim for achievement of best performance in harmony with the performance of the organization.
- iv. **Management Motivation:** There should be adequate and whole-hearted encouragement from the managers in the achievement of organizational goals. Without the cooperation and participation of unit managers, the implementation of management control would become a difficult task.
- v. **Fairness and Straightforwardness:** The effort and motivation of the managers depend on the degree of fairness, straightforwardness and objective component that is built in the design of the management control system. The achievements and the degree of deviation from the established controls must be objectively established at the end of the period for which goals are being set.

## 2.1 The Control Process Hierarchy

The control process in an organization involves the relationship between the superior and the subordinates. The relationship is between superiors and subordinates because the superior communicates the goals of the organization to the subordinates, who, in turn, devise strategies to achieve them. The goals of the subordinates should be congruent to the goals of the superior. Congruency in goals can be achieved through negotiation, and depends on the style of management and the communication process in the organization. In a hierarchical organization with decentralized decision-making and authority, the control process begins with the superior meeting the subordinates and negotiating goals, objectives and targets for the next year. After the goals are finalized, the performance is tracked at periodic intervals. The superior and subordinates review the overall performance. In areas where performance has been unsatisfactory, they try to find the reasons for the unsatisfactory performance. Once the reasons are identified, a plan of correction is prepared. This plan is prepared on the basis of past corrective actions and the current performance. Thus, the targets and course of action for the next year are set.

The same process is carried out throughout the organization. A reward system based upon the performance of the employees is designed. First, managers decide on the targets they want to give their subordinates. Next, there is negotiation between the superior and the subordinates with regard to the targets. At this stage, it can be analyzed whether the subordinates' objectives are in congruence with the objectives of the superior. All the targets should be specific and measurable. There should be a limited number of targets, so that they can be managed well. The targets should cover qualitative variables (employee training and development, and new product development) as well as quantitative variables. To summarize, the goal-oriented control process follows the cybernetic paradigm and involves planning, decision-making and controls. It operates through a hierarchy of control, and its main purpose is the attainment of organizational goals and objectives.

#### 2.1.1 DECENTRALIZATION

It is necessary for every organization to decentralize the decision-making authority, so that sub-goals can be set. In this way, every decision-maker is made responsible only for a small portion of the overall organizational objective. Decentralization ensures that the decision-maker arrives at the right decision by making use of sufficient information. However, decision-makers should find ways to deal with the complexity in the organizational environment even when the information available to them is limited.

# 2.1.2 ORGANIZATIONAL SLACK

Cyert and March define organizational slack as "the disparity between the resources available to the organization and the payments required to maintain the coalition." Organizational slack occurs when an organization under-exploits its environment. This under exploitation results in higher salaries, wages and perquisites than necessary to carry out the goals and objectives of the firm. Dividends may be higher than necessary to maintain the confidence of shareholders. But, in terms of management control systems, slack acts as a cushion against changing the business environment and provides resources for innovation and adaptation in various areas. As organizational slack cannot be prevented at all times, the organization should ensure that slack resources have strategic value and are not simply idle resources.

The stakeholders of an organization include investors, customers, employees, suppliers and the public. It is necessary for the organization to determine the goals and objectives, and performance measures of each of the above categories. A functional structure is designed keeping these goals in view and then managerial controls are designed for departments of the organization. Based on the relationships and the goals, organizations exercise control over stakeholders. The analysis of stakeholder relationships begins with identifying all the stakeholders. The next step is to distinguish the most important stakeholders. This group consists of stakeholders who are highly influential, powerful insofar as the organization's decision-making process is concerned. The next step is the analysis of the inducements that can be offered to the stakeholders. Inducements can include material rewards, power, distinction and participation in the activities of the organization. Next, the contribution for a particular stakeholder has to be analyzed. Contributions include capital, revenue, performance and community support. Finally, the competition for a particular stakeholder is analyzed. All these steps help the company in identifying crucial stakeholder variables that help in monitoring and influencing the control process.

The formal and informal communication within an organization include meetings, day-to-day contacts among managers, body language etc. All these formal and informal communications are crucial in understanding and improving the control process.

Let us now discuss how communication structures support control process with the help of information systems.

The first element of the information system is a formal or informal process, which scans the environment in which an organizational subunit operates. After this the organization requires a planning process. The planning stage is the most crucial of all, as it involves four sub-processes namely, strategic planning, business planning, long range planning and operations planning. All these processes would remain incomplete without proper communication across various levels of the organizational hierarchy. Feedback is necessary after the completion of each stage (environmental scanning, planning). The feedback is compiled in the form of a report. This is followed by decision-making procedures and implementing them.

# 2.2 Impact of Information Technology on Control Systems

Information technology has benefited traditional control systems in many ways.

- Data can be managed more easily and at a reasonable cost.
- The various departments of the organization can work towards achieving the organization's goals and collaborate for fast decision-making.
- Data can be collected for strategic and operating decisions.

As control systems operate in all the areas of an organization, any change in them requires changes to be made in the overall structure and strategies of the organization. Therefore, managers should take right decisions in choosing what type of technology the organization needs. Technology should be used for making work easier. Organizations should not indulge in complex and expensive systems such as costly data storage systems.

The decline in the cost of information processing led to the rise of ABC (Activity Based Costing) systems. These systems provide accurate cost data for the operational and strategic decisions in an organization. The availability of an electronic equipment, called the optical scanning equipment, has improved the efficiency of inventory control techniques. This equipment is also used to conduct market research by noting customers' demand patterns.

# 2.3 Designing Control Systems for Managerial Styles and Corporate Culture

Management style and corporate culture play an important role in designing the control system. While management style is related to the individual manager, corporate culture relates to the overall organizational concept. In fact, management style and corporate culture are related to each other. The style of a manager influences the style of other managers in the organization and the culture of the organization. Culture consists of shared values and norms of the organization and this influences the prevailing style of the management. Hence, management style and culture are intertwined.

## 2.3.1 MANAGERIAL STYLES AND THE DESIGN OF CONTROL SYSTEMS

Managers differ in their styles of managing employees. The different styles have an impact on the design of the control systems. If the control systems are not designed with the managerial style in mind, then conflicts might arise between organizational goals and managerial styles. The different managerial styles that influence the design of control systems are external control, internal control and mixed control.

- i. **External Control Style:** External control works on the premise that subordinates can be motivated through rewards. This style is authoritative and mechanical as the organizational goals are set by the top management. The style also ensures the following:
  - Set difficult goals so that the employees need to stretch themselves.
  - Form strict regulations so that employees are not able to manipulate their tasks.
  - Embed adequate incentives in the performance assessment systems, so that employees are motivated to perform.

This type of control has its advantages and disadvantages.

The advantages of this type of control are:

- Subordinates may be motivated to perform, as rewards are directly linked to performance.
- Because of high control executed by the top management, superiors will be able to monitor subordinates, work and there would be no manipulations.

The disadvantages of this type of control are:

- Employees will not have any commitment towards the organization. They will perform only to obtain rewards and benefits.
- Employees will concentrate only on one aspect of their job and ignore the rest. They may concentrate on increasing the sales volume, and ignore customer service.
- Only the positive outcomes of a particular task would be informed to the higher authorities. The negative information about it will be withheld, fearing deduction in incentives.
- Employees will invest all of their potential in their area of work and ignore other aspects that are important for the well-being of an organization as a whole.
- ii. **Internal Control Style:** This style works on the premise that subordinates will be motivated and committed towards the organization if they are involved in the decision-making process. This style assumes that employees will experience a sense of achievement, recognition and self-esteem if they are involved in the decision-making process. The following strategies are important to implement internal control style:
  - The management style should be participatory in nature as the employees are involved in the process of decision-making. The emphasis here is not so much on achieving the goals, but on how well they are set.
  - Strategies are designed to solve problems jointly, and not to blame a particular individual for its occurrence. When an employee's performance moves in an undesired direction, the subordinates and managers meet to identify the reasons for this and to develop appropriate solutions to the problem.
  - Rewards in this system are not based on one or two specific measures of performance, but on accountability of the overall performance. This management style does not punish an employee for his past actions, but intends to improve his performance in the future.

Advantages of internal control style are as follows:

- It inspires high levels of commitment and motivation in the employees. Since the employees also take part in the decision-making process they are more focused on achieving the targets.
- This type of control encourages accountability towards the work and an open work atmosphere.

This style has certain disadvantages too. They are:

- It exercises loose control within the organization. In this situation, managers will have less control over their subordinates.
- The information provided in this control is basically meant for identifying the problems and suggesting corrective action. Hence, it does not work as an evaluation tool for rewarding employees.
- Employees who are not willing to participate in this kind of management may not perform well.

- iii. **Mixed Control Style:** The two types of control styles discussed above have their own advantages and disadvantages. Hence, a manager has to carefully analyze the benefits of each style and carefully choose the style that would be most beneficial for the organization. Roy Ash, founder of Litton industries, made use of the mixed control style. His style consisted of the following characteristics:
  - **Infrastructure:** For a diversified organization like Litton, the appropriate approach to decision-making and problem-solving should be analytical in nature. Roy Ash used the same approach. He chose people who possessed strong analytical powers and strategic skills.
  - **Rewards:** Roy Ash selected only the best people and made sure that they were given their dues they deserved.
  - **Communication and Integration:** Roy Ash arranged numerous small meetings in order to communicate with people more frequently.
  - **Control Process:** Though the financial plan at Litton was presented yearly, it was updated monthly and quarterly. Performance reports against plan and cash flow statements were prepared weekly. The numerical reports were fewer in number.

Just as an organizational strategy is important for the implementation of organizational plans, a control system and the way it is implemented play an important role in making an organization and its employees more productive.

## 2.4 Corporate Culture and Design of Control Systems

Management control is the process by which an organization ensures that its sub-units act in a coordinated and cooperative fashion so that more resources could be obtained and optimally allocated in order to achieve the organization's goals. Corporate culture consists of shared values, common perceptions and common premises that the members of an organization use to achieve goals. Organizational culture influences several basic premises of an organization and, hence, has a major influence on the organizational goals. Thus, while designing management control systems, the heads of an organization should take their culture into consideration. Bureaucracies, markets and clans are three types of corporate control mechanisms that exist in varying degrees in different organizations. Bureaucracy follows strict formal rules, procedures and directives. It has clearly defined roles for each member of the organization. The most important component of a market based approach is giving incentives to motivate performance. In the case of the clan control mechanism, the organization depends on values and beliefs to boost performance. Values and beliefs are conveyed to the employees at all levels, initially through recruitment and socialization process and subsequently through training and development. Corporate culture helps in the overall coordination of all the activities of an organization. In an organization, where the goals and values are shared by the individual members, problems are minimized and a sense of group loyalty prevails. For example, consider the design of belief system for employees:

- Respect for the individual,
- Customer service,
- Dedication to work towards excellence,
- Decentralized business,
- Total quality management, and
- Empowerment of people.

Employees should also be rewarded appropriately for understanding and implementing the suggestions proposed by the management and achieving new goals. Sometimes, as a result of resistance from the leader certain changes are not implemented. In such cases, it is better to change the leader. After the change has been implemented, it is important to extend it on to other sub-systems of the control system.

## 2.4.1 IMPACT OF CORPORATE CULTURE UPON CONTROL SYSTEM

Culture becomes an important asset of an organization when it is properly imbibed in an organization. Conversely, it is a liability when it adapts poorly to the environmental needs of the organization. The strength of culture depends on the following three factors:

- The assumptions made by the organization,
- The clarity of the assumptions, and
- How well they are shared within the organization.

A control system must be so designed that it fits the existing culture of the organization. This can be done by stressing on the values that the management wants its employees to follow and rewarding them for achieving goals based on these values. In order to foster desirable values in an organization, the subsystems and components of its formal control systems should be so changed as to inculcate these values.

## 2.4.2 ESTABLISHING A CUSTOMER FOCUSED TOTAL QUALITY CULTURE

Organizations in the present day competitive environment need to concentrate on customer satisfaction. In markets that offer a number of options to buyers, companies can place themselves in an advantageous position by concentrating on customer focused total quality culture. While, on one hand, organizations have to respond to the needs of the customer, on the other hand, they have to increase their efficiency to compete with others in the business. Total Quality Management (TQM) ensures that organizations attain the efficiency targets as well as satisfy customers. Thus, TQM can be described as a system that emphasizes customer satisfaction and commitment to continuous improvement of its services and products to meet the needs of existing and potential customers, through empowerment and active involvement of all the staff.

TQM follows a cybernetic paradigm in solving problems:

- First, the top management makes clear to the rest of the employees the key philosophical principles of TQM.
- The top management then sets up a companywide quality improvement program. This program consists of a quality improvement team which is formed according to the mission and target of the organization. The main task of the team is to communicate the various philosophies and charter subunit teams in a hierarchical fashion.
- The next step involves each team coming up with ideas about products and services that need to be launched. It also involves manufacturing products according to the expectations of the consumers.

# 3. BUDGET AS AN INSTRUMENT OF CONTROL

Organizations prepare plans for the successful execution of strategies. A budget is a financial and quantitative statement, prepared and approved prior to a defined period of time, of the policy to be pursued during that period for the purpose of attaining a given objective. Budgeting refers to the process of designing, implementing and operating budgets. The budgeting process starts with the dissemination of guidelines approved by the senior management. Budgetary control refers to the establishment of budgets that relate the responsibilities of executives to the requirements of a policy, and the continuous comparison of actual with budgeted results, either to secure by individual action the objective of the policy or to provide a basis for its revision. Managers should participate in the budgeting process to ensure consistency in the overall adherence to the corporate goals. In this section we will discuss the concept of budget, budgetary control, and the variances that arise in the budgetary process.

# 3.1 Need for Budgeting

Budgets are essential aids in planning because they force the managements to think ahead and look before they leap. Budgets are needed for the reasons given below:

- Budgets reduce uncertainty by allowing executives to map out the future course of action. This helps the organization face challenges with confidence.
- Budgets increase coordination among the different departments because budgetary control forces executives to think as a group. All the departments in an organization tend to function in a well-coordinated manner in an attempt to implement the planned courses of action systematically. Budgeting also helps managements coordinate the activities of business to the economic trends.
- Budgets identify weaknesses by finding out the reasons for inefficient performance. They help management trace discrepancies in any activity of the business and take suitable remedial measures.
- Budgets help managers analyze the expenditure and keep it under check, thereby preventing wastage of all kinds.
- Budgets help in the establishment of performance standards for operational activities and the adoption of the standard costing technique.
- Budgets help identify deviations from pre-planned courses of action. Managements can later analyze the causes for the deviations and implement remedial measures.
- Budgets help establish standards of performance. Evaluating performance against standards enables employees to analyze their strengths and weaknesses.

To summarize, budgeting is an action plan that is necessary for controlling all aspects of the operations of an enterprise for a definite period of time.

## 3.2 Forecasting, Budgeting, and Strategic Planning

Budgeting is different from strategic planning and forecasting. A Forecast is an estimate of what is likely to happen under anticipated conditions during a specified period of time, whereas a budget shows the policy and program to be followed under planned conditions during a specified period. Forecasts are statements of future events. A budget however is a tool of control. Forecasting is a preliminary step in the process of budgeting. Where forecasting ends, budgeting begins. Forecasts have a wider scope than budgets. Forecasts can be prepared for any period of time and updated whenever new information is made available. Finally, variances from forecasts are not analyzed formally or periodically. From the point of view of management, a financial forecast, which includes estimates of revenue, expenses and other items that affect the cash-flow is exclusively a planning tool, whereas budget is both a planning and control tool.

Strategic planning is different from budgeting in the sense that it focuses on activities that extend over many years, whereas budgeting usually focuses on activities that take place within a year. Strategic planning provides the framework for the preparation of annual budgets. Strategic planning is formed on the basis of product lines or other strategic programs while budget is structured on the basis of allocation to responsibility centers.

# 3.3 Budgeting Process and Control

Three important aspects of budget process and control must be discussed. They are:

- Budget preparation process,
- Budgetary control, and
- Behavioral dimensions of budgeting.

#### 3.3.1 BUDGET PREPARATION PROCESS

Information is essential for preparing a sound budget. Budgets are prepared by managers; the information or the input data needed for budget preparation is developed by people lower in the hierarchy according to their responsibilities and functions. Managerial forecasts and accounting reports are a major source of data for budget preparation. Managerial forecasts provide data on the anticipated level of activity, while accounting reports provide data on the financial magnitude of past and current operations. The formulation of the budget involves the following steps:

i. Organization

**The Budget Department:** The budget department disseminates the information during budget preparation. The members of the budget department report to the corporate controller. The functions of the department include:

- Publishing procedures and forms for the preparation of the budget.
- Ensuring that the information is communicated in the right way between the different organizational units.
- Analyzing the proposed budgets and making corrections and recommendations whenever necessary.
- Carrying out budget revision at regular time periods.
- Coordinating the work of the business units connected to the budget department.
- ii. The Budget Committee: The budget committee consists of the heads of various departments within the organization and members of senior management such as the CEO, financial vice president, etc. The function of the budget committee is to review budgets, approve them, and make adjustments wherever necessary. In some companies, the CEO decides on the budget without the help of any committee. While in some companies, the budget committee meets only the senior operating executives, in some other companies, the budget committee discusses the budget with the business unit managers.
- iii. **Issuance of Guidelines:** The first step in the budget preparation process is the issuance of guidelines. The main source of these guidelines is the strategic plan of the organization, which is modified from time to time according to the company's performance. Budget guidelines are developed by the staff of the budget department, and these guidelines are approved by the senior management. Sometimes, lower-level managers are also consulted for the finalization of guidelines. After the senior management has approved these guidelines, the timetable for budget preparation is disseminated throughout the organization.

The guidelines issued by the budget department have to be followed by the responsibility centers. Some guidelines for responsibility centers are based on important issues like inflation, wages, promotions and transfers, compensation etc. These guidelines submitted by the responsibility centers would be a source of input data at the time of budget preparation. However, in many companies the budget preparation process begins as soon as the strategic plan is approved.

iv. **Initial Budget Proposal:** The managers of different responsibility centers within the organization develop a budget 'request' for facilities, personnel, and other resources. However, these budget requests are modified according

to the guidelines issued to the responsibility centers. The changes responsible for the frequent modifications of budget requests are:

*Changes in external forces:* These include changes in the level of economic activity, changes in the labor rates, changes in the purchased materials and services, changes in the selling price, and changes in the cost of discretionary activities like R&D.

*Changes in internal policies and practices:* These include changes in market share and product mix, and changes in production cost and other discretionary costs (which are based on changes in workload).

- v. **Negotiation:** The budget planner discusses the budget proposal with his superior. The superior judges the validity of each of the adjustments made in the budget proposal. The major consideration in this step of budget formulation is that the performance in the budget year be an improvement over the performance in the previous year.
- vi. **Slack:** In most organizations budgetees (the people, who prepare budget proposals) tend to budget revenues lower and expenses higher than their best estimates of these amounts. The difference between the budget amount and best estimate is known as 'slack.' It is the duty of the superior to discover and eliminate slack.
- vii. **Review and Approval:** The budget proposal developed by the budgetee goes up through successive levels in the organization. If at one level the budget is not found satisfactory, it is sent back for reworking. The budget committee presents the fully developed and reworked budget to the CEO. The final approval is made by the CEO. The CEO then submits the approved budget to the board of directors. This process of approval of budgets takes place in the month of December, just before the beginning of the budget year.
- viii. **Budget Revisions:** Budgets are revised from time to time in order to check discrepancies, if any. Generally, two procedures are followed for revising budgets:
  - Procedures that provide for a systematic updating of budgets.
  - Procedures that allow revisions under special circumstances.

Systematic updating of budgets requires extra work by the budgetee. Large Japanese companies generally update budgets. In these companies, the budget is prepared for the whole year. Senior managements formally approve the budget during the first six months of the budget period and for the next six months the budget is revised and approved shortly before the budget period begins. Budgets may provide for activities that are planned months ahead of the time they take place. Thus, management activities should be based on the latest information available.

Budgets are revised only when they are no longer useful as control devices. However, it is difficult to get permission from the top management to do so. Frequent revision of the budget indicates that the budget is not well prepared.

ix. Administration and Review of Budgets: The authority of administration of budgets vests with the top management. A budget can be successful only if it is properly administered. A budget manual is necessary to facilitate the process of administration of budgets. The budget manual contains objectives of budgeting, the process of budgeting, and the tasks and responsibilities of the departmental heads and individual managers in the preparation of the budget. Many organizations set up budget committees at divisional offices as well as at corporate headquarters. The budget committee at the corporate headquarters consists of managers of different divisions. When some large autonomous institutions come together to form a federation, a 'programming committee' is formed. This committee consists of managing directors of the different institutions. The programming committee also coordinates the activities of the individual members of the union.

A major aspect of the administration of budgets is the revision of budgets. Budgets can be revised only in extraordinary situations, when not revising will significantly affect the budget results. Budgets are also revised when they become unrealistic, when budget assumptions are proved incorrect, and when they are no longer useful as control devices.

After the budget has been finalized by the budget committee or the senior management, it must be reviewed and approved. Budgets are reviewed and approved to ensure that the departmental and divisional budgets are consistent with overall organizational goals. For example, is the production budget consistent with the planned sales volume? Are service and support centers planning for the services that are being requested of them? The purpose of the review is to ensure that the budget produces a satisfactory profit.

Budgets are prepared and finalized in accordance with the standards set by the top management. Since budgets are used to evaluate the performance of various responsibility centers, managements must set standards that are attainable. If standards are too difficult to attain the responsibility centers may manipulate figures to please the top management.

# 3.4 Budgetary Control

The purpose of budgetary control is to find out how the activities of an organization are progressing. To achieve budgetary control, actual results are compared and measured with anticipated results as provided in the budget. If any differences are noticed, the budget estimates can be re-examined and necessary corrective actions can be taken. While a budget is a 'means' budgetary control is the 'end result'. According to The Institute of Cost and Management Accountants, London, budgetary control is the establishment of budgets, relating the responsibilities of executives to the requirements of a policy, and the continuous comparison of actual with budgeted results, either to secure by individual action the objective of that policy or to provide a basis for its revision. Budgetary control focuses attention on deviation from budget standards and points out where corrective action is necessary. The budgetary controller, who consults with various heads of departments of the organization is responsible for the budgetary control.

#### 3.4.1 IMPORTANCE OF BUDGETARY CONTROL

Budgetary control has a number of advantages. The following are some of the advantages:

- i. **Presentation of Overall Managerial View:** Budgetary control offers an overall picture of the various functions in an organization. In other words, it presents a managerial view of all the activities within an organization. Such an overall perspective is essential for management success.
- ii. Narrows Down the Gap between Planning and Performance: In many organizations there is usually a big gap between planning and performance. Budgetary control bridges the gap between planning and performance by anticipating the results of courses of action, by comparing the actual results with anticipated results, and setting up proper standards for performance.
- iii. Promotes Division of Work and Specialization: Budgetary control helps in the allocation of responsibility and accountability for performance to each member of the organization. It thus promotes division of labor. Division of labor in turn promotes the process of specialization, which helps improve the overall efficiency of the organization.
- iv. Fosters Coordination and Integration: Budgetary control helps managers in coordinating the activities of the organization. The interaction between the employees during the budget development process helps integrate the activities of the organization's members. The budget controller conducts meetings with the heads of various departments within the organization and thus fosters coordination and integration between various departments. Budgetary control thus brings about the integration of policy, plans, and actions of the different departments.

Budgetary control is done systematically as follows:

- Determining the objectives.
- Establishing the budget centers.
- Introducing adequate accounting records and assigning verifiable codes to them.
- Preparing a budget organization chart that defines the functions and responsibilities of each member of management.
- Establishing a budget committee which consists of key members of the organization, chief executive officers and budget controllers. The main function of a budget committee is to coordinate the budget activities, review the budgets, suggest revisions and approve the budgets.
- Preparing the budget manual to develop a schedule to identify who is responsible for what in the organization. The budget manual consists of accounting codes, a budget timetable, budget periods, a budget proforma etc.
- Selecting the budget period. This is done keeping in view the nature of the strategic plan, nature of the business, production period, financial aspects of the business, etc. Usually, a time period of one year is considered the budget period.
- Locating the principal factors that influence the budget. The key factors should be correctly identified and examined. For example, the principal budget factors for a sales budget would be consumer demand, marketing, advertising, etc.
- Determining the budget cost allowance a budget center is expected to incur during a given period of time in relation to the level of activity attained by the budget center.

#### 3.4.2 ORGANIZING BUDGETARY CONTROL

Systematic administration and successful implementation of budgetary control results in sound budgets for the enterprise. The following steps should be considered to achieve effective budgetary control:

- Organizing for budgeting,
- Assigning responsibility for budgeting,
- Determining the budget period,
- Determining the key success factors, and
- Preparing the budget report.
- i. Organizing for Budgeting

**Budget Center:** A budget center is a section of an organization developed for the purpose of budgetary control and is intended to facilitate the formulation of various budgets with the help of the heads of the concerned departments. Budgetary control focuses attention on the attainment of the objectives of various departments within the organization or the enterprise. Therefore, the enterprise must have a clear perspective of the objectives that are sought to be achieved through budgetary control. A budget center is established after developing a clear perspective of the objectives that are to be achieved through budgetary control.

**Budget Manual:** This is a written document that contains standing instructions regarding the procedures to be followed at the time of budget preparation. A budget manual is maintained to inform the concerned executives about the procedures to be followed during budget preparation and

to avoid frequent instructions from the controller's office. A budget manual contains guidelines for the following:

- Functions of various officials connected with the formulation of budgets. Steps in the preparation of various budgets.
- Scheduled date of submission of budgets.
- Review and approval of various budgets.
- Final adoption of budgets.
- Timetable for budget operations.
- Records, reports, and forms to be maintained for the purpose of budget operations.

## ii. Assigning Responsibility for Budgeting

In an organization, the budget controller and the budget committee are responsible for budgeting.

**Budget Controller:** The entire process of budgetary control is handled by the budget controller. The budget controller should be experienced in handling various budgets and should be able to identify and analyze the deviations from the set standards and initiate corrective measures for the same. An important function of the budget controller is to advice the management on important issues such as budget preparations, revision of budgets, approval of budgets etc. The budget controller reports directly to the chairman.

**Budget Committees:** The budget committee consists of the heads of various departments within the organization, viz. production, marketing, finance, administration, and accounts. The members of the committee discuss the budget figures (and probable estimates) before arriving at a final decision before finalizing the budget.

- Determining the Budget Period: The budget period refers to the time period iii. for which the budget is being prepared. A budget can be a long-term or shortterm budget depending on the time period. A budget prepared for one year or less is called a short-term budget. A budget can also be prepared on a quarterly, monthly or weekly basis depending on the requirements of certain operations. Examples of short-term budgets are annual sales, income and expenditure budgets. A long-term budget covers a period of five years or more. These budgets are prepared when an organization plans for expansion, modernization, diversification etc. Long-term budgets are used for the purpose of planning while short-term budgets which are designed to implement these plans are used for control purposes. Examples of long-term budget are capital expenditure budgets and research and expenditure budgets. The time period of a budget can vary depending on the nature of the business, and the production period. Electronics and consumer goods industries prefer to prepare annual budgets as they experience a high rate of change. For industries such as shipbuilding, the time period of budget may vary between 5 to 10 years.
- iv. **Determining the Key Factors:** The key success factors are those factors that influence the performance of an organization. These factors influence the limit of output and thus have a direct impact on the profitability of an organization. The key success factors include the availability of raw material, skilled labor, cash etc. If any of these is in short supply, work can be delayed. Due to changes in the internal and external conditions, the key success factors can change from time to time. In some organizations, the critical success factors are consumer demand or expected level of revenue. In such organizations, the sales budget should be prepared first. This budget will determine the content of other budgets. In some other organizations, the most critical success factor can be productive capacity.

v. **Preparing the Budget Report:** It is essential to compare actual performance with the anticipated budgeting performance; and the results of the comparison should be brought to the notice of the management through reports. The reports should furnish details of the responsibility of each department or executive in budget preparation and the reasons for variances in actual and budgeted performance so that corrective actions can be initiated.

# 3.5 Zero-Based Budgeting

In Zero-Based Budgeting (ZBB), all the activities are reevaluated each time the budget is prepared. In ZBB, each functional budget assumes that the function does not exist and that the costs are zero. Budget preparation for each function starts with the basic premise that each activity is being performed for the first time and that the cost of each activity is zero. The assumption is that the budget for the coming year is zero and every process or expenditure has to be justified in order to be included in the budget. The manager is held responsible for identifying the resources required for each activity by explaining what would happen if the proposed activity was not carried out and no money was spent on that activity. In ZBB, a number of alternatives for each activity, and the associated costs, have to be identified so that the one that offers the most benefits can be selected. The basic requirements for the application of ZBB in an organization are: the presence of a budgeting system in the organization and the ability of the managers to develop qualitative measures for performance evaluation.

The important features of ZBB are:

- The budget requires the manager to explain the need for spending a particular amount on an activity.
- The selection of each activity is made on the basis of what each unit can offer for a specific cost.
- The targets of individual units are linked to the overall corporate targets.
- The budget requires participation of all the employees at the different decision making levels.
- The budget has the advantage of maintaining the expenditure level according to the operating costs.

## 3.5.1 THE ZBB PROCESS

There are three basic steps in ZBB. These steps are discussed below:

- i. Identifying Decision Units and Developing Decision Packages: Decision units are synonymous with responsibility centers. These units should be given a prominent place in the organizational chart. Examples of decision units are research and development and capital expenditure units. A decision package describes the activities that take place in a decision unit. A decision package describes the goals and objectives of each activity, identifies specific measures of performance, and states the projected costs of the package etc.
- ii. **Evaluating and Ranking the Decision Packages:** In this step, the decision packages are reviewed and ranked in the order of decreasing benefit to the firm. Ranking is done on the basis of a cost-benefit analysis.
- iii. Allocating Resources Accordingly: Top management allocates resources on the basis of the ranking of the decision packages. The total available resources will determine the acceptable expenditures. Before allocating resources, the available resources are forecasted and matched with the ranked decision packages on a cumulative amount basis.

#### 3.5.2 ZBB Vs TRADITIONAL BUDGETING

ZBB is not based on the previous year's budget, whereas traditional budgeting uses the previous year's expenditure level as the base. The main differences between traditional and zero-base budgeting are:

- Traditional budgeting is accounting oriented and is based on the previous year's level of expenditure. The focus of this type of budgeting is determining the additions and subtractions that need to be made in the present budget on the basis of the previous year's budget. ZBB is decision oriented. It relies on the manager's decision regarding the costs required for carrying out a particular activity.
- In traditional budgeting the budget is sometimes inflated by managers; but in ZBB, a rational analysis of the budget is made.
- In traditional budgeting the top management is usually involved in the preparation of the budget, whereas in ZBB the responsibility center manager takes the necessary decisions.
- In ZBB it is easy to identify the important projects that require management attention, whereas in a traditional budgeting it becomes difficult to identify the priority items.

## **3.5.3 IMPLEMENTING ISSUES**

The successful implementation of ZBB requires the clear statement of the corporate objectives and the identification of decision units on the basis of functions or departments. The function of each division and the targets it plans to achieve must be clearly defined and analyzed. In addition, the performance of each activity must be analyzed. The analysis should include a clear description of each activity, the alternate methods and costs involved in each activity and the ability to evaluate each activity. Each activity or decision package must be evaluated through a cost benefit analysis.

## 3.5.4 ADVANTAGES AND DISADVANTAGES OF ZBB

The benefits of implementing ZBB system for an organization are:

- It helps the organization identify the activities that lead to unnecessary expenditure. Since the manager of the responsibility center is involved in the preparation of the budget, he can frame the budget keeping in mind the requirements of a particular center. Thus, wasteful expenditure is reduced.
- Since the budget is evaluated on the basis of a cost benefit analysis, unnecessary costs are reduced. An activity is taken up only after detailed analysis of various alternatives in terms of cost allotment.
- ZBB leads to organizational development because it improves communication and leads to wider participation within the organization. ZBB also leads to a clear identification of the aims of the organization.
- ZBB encourages cost effectiveness and efficiency and allows for quick budget adjustments if revenue falls short during the year.
- The involvement of all the managers in the preparation of budget ensures their commitment to the successful execution of the budget.

#### 3.5.5 LIMITATIONS OF ZBB

ZBB has been criticized for the following reasons:

- It leads to an increase in paperwork and emphasizes short-term benefits instead of long-term benefits.
- In ZBB, decisions are based on the ranking of the decision packages. However, when formulating the budget, the management must also consider the opportunities and threats presented by each activity.

- The managers of the responsibility centers require adequate training to take the necessary decisions and require adequate management skills to take constructive decisions.
- ZBB does not offer significant advantage when determining the costs of research and developmental activities. Even though ZBB has been criticized for many reasons, it is considered to be highly relevant in a continuous improvement environment as it involves continuous evaluation of activities and results in effective cost-benefit decisions.

# 3.6 Performance Budgeting

The term performance budgeting was first introduced by the Hoover Commission in 1949. It can be defined as a budgetary system in which input costs are related to end results. The cost and production goals are first established and they are later compared to actual performance. This method of budgeting leads to an improvement in management efficiency. It involves analyzing, identifying, simplifying and crystallizing the specific performance objectives of a job to be achieved over a period within the framework of organizational objectives. Performance budgeting puts more emphasis on expenditure incurred on functions than on things to be acquired or spent. In performance budgeting, each program is further sub-classified as an activity. In traditional budgeting system, budget appropriations are made object-wise and clubbed according to the nature of expenditure such as pay and allowances, traveling allowances, transport, traveling allowances etc. The budgeting system is aimed at fulfilling the objectives of the business. The main features of a performance budget are:

- It presents the purposes for which funds are required and brings out the programs and accomplishments in financial and physical terms.
- It presents the costs for achieving the various activities along with the quantitative data for measuring the accomplishments.
- It presents the expected level of performance for each activity.
- It acts as an effective performance audit.
- It provides additional tools for management control of the organization's finances.

## 3.6.1 STEPS IN THE IMPLEMENTATION OF PERFORMANCE BUDGETING

The main steps in the implementation of the performance budget are:

- Classification of the activities,
- Specification of objectives,
- Analysis of activities,
- Establishment of control norms,
- Establishment of authority and responsibility, and
- Evaluation of the budget.
- i. **Classification of the Activities:** This is the first step in the implementation of the performance budget. The activities divided into programs depending on their time frame and resources are divided based on their importance. For example, in an organization, marketing programs can be classified into public relation activities, advertising activities etc. An activity is thus a subdivision of the program to which resources are applied.
- ii. **Specification of the Objectives:** In this stage, the objective of the individual activity is clearly defined. Then, the resources that have to be spent for each activity are clearly outlined. The annual, monthly targets are determined for each activity center.

- iii. Analysis of Activities: The long-term strategy and short-term tactics for achieving the desired objectives are considered. Also, the possible alternative activities are identified and their costs and benefits are worked out. Then, the activities that come closest to achieving the organizational goals are selected.
- iv. Establishment of Control Norms: Control norms are established in the form of productivity ratios and performance ratios. These are compared to actual performances. Norms are also set for non-financial measures of performance.
- v. **Establishment of Authority and Responsibility:** The authority and responsibility for different activities are clearly identified and the functions of the activities are clearly demarcated. Financial rules and accounting systems help in the effective implementation of the activities.
- vi. **Evaluation of the Budget:** To find out if the projects have been implemented according to the plan, information and reporting systems (related to financial, economic and physical data) are installed to monitor the execution of the activities.

## **4. VARIANCE ANALYSIS FOR CONTROL ACTIONS**

Since a budget is an instrument of control, it is necessary to compare the actual results with the budgeted results. A variance occurs whenever actual costs differ from standard costs. The term variance analysis refers to the systematic evaluation of variances in an attempt to provide managers with useful information for measuring efficiency and improving performance. Variance analysis attempts to isolate the impact of each important variable that contributes to the total variation. Variance analysis is done to investigate the underlying causes for deviations in budgets so that managements can take corrective measures. Thus, variance analysis examines the amount of difference between standard costs and actual costs and the reason for the difference.

If the actual cost is less than the standard cost, the variance is favorable. If the actual cost is more than the standard cost, the variance is unfavorable. A favorable variance indicates efficiency and an unfavorable variance indicates inefficiency.

Variances occur due to three reasons. A managerial decision to respond to some new developments which were not initially anticipated, uncontrollable exogenous factors, and controllable factors that need to be investigated.

The following framework can be used to conduct variance analysis:

- Identify the key causal factors that are likely to affect the profits.
- Breakdown of the overall profit variances according to the key causal factors.
- Focus on the profit impact of the variation for each key causal factor.
- Determine the specific, separable impact of each causal factor by varying a particular factor while holding all others constant.
- Add complexity sequentially to determine the impact of several variables on a particular factor.
- When the added complexity at the newly created level is not justified, the process has to be stopped.

## 4.1 Revenue Variances

Selling price, volume and mix variances come under revenue variances. The variance for each product line is calculated separately and the results are aggregated to calculate the total variance. If the actual profit exceeds the budgeted profit, the variance is positive and favorable, but if the actual profit is less than the budgeted profit, the variance is negative and unfavorable.

#### **4.1.1 SELLING PRICE VARIANC**

The selling price variance is calculated by multiplying the difference between the actual price and the standard price by the actual sales volume.

#### 4.1.2 MIX AND VOLUME VARIANCE

Mix and volume variances are not separated in general. The mix and volume variance is the product of the budgeted unit contribution and the difference of the actual and budgeted sales volume.

The volume variance results from selling more units than the budgeted. The mix variance results from selling a different proportion of products, as the contribution per unit is different for different products. If the business unit has a 'richer' mix (i.e., a higher proportion of products with a high contribution margin), the actual profit will be higher than the budgeted. Mix variances and volume variances can also be calculated separately.

#### 4.1.3 MIX VARIANCE

The following equation is used to calculate the mix variance for each product.

Mix variance = [(Total actual volume of sales x Budgeted proportion) (Actual volume of sales)] x Budgeted unit contribution.

Volume variance: Volume variance is calculated using the following formula:

Volume variance = [(Total actual volume of sales) x Budgeted percentage)] - [(Budgeted sales) x (Budgeted unit contribution)].

## 4.1.4 MARKET PENETRATION AND INDUSTRY VOLUME

One extension of revenue analysis is to separate the mix and volume variance into the amount caused by the differences in market share and the amount caused by differences in industry volume. This is because while the business unit managers are responsible for market share, they are not responsible for industry volume as state of the economy decides the industry volume. For this purpose, the industry sales data is also needed to exactly represent the performance of a business unit.

Market share variance and industry volume variance are calculated using the following equations.

Market share variance	=	[(Actual sales) – (Industry volume) x Budgeted market penetration] x Budgeted unit contribution
Industry volume variance	=	[(Actual industry volume – Budgeted industry volume) x Budgeted market penetration] x Budgeted contribution per unit.

The variance for each product is calculated separately, and the sum of variances of all the products gives the total variance.

## **4.1.5 SALES BUDGET VARIANCES**

Sales budgets are prone to variances because actual sales usually differ :trom budgeted sales. It is the duty of the concerned managers to analyze and understand the factors that have caused the deviation. In most organizations, three principal reasons are responsible for deviations in sales budgets:

- i. The actual price realized is different from the price envisaged at the time of budget formulation.
- ii. The actual volume of product sold is different from the planned volume of sales.
- iii. The actual sales mix is different from the budgeted sales mix.

Variance in the sales budget is categorized as a price variance and volume variance. Volume variance is analyzed in terms of a sales-mix variance and a quantity variance. The same approach is used to analyze a territory-wise sales performance report. If a sales district projects a high variance, then it is necessary to analyze and understand the reasons for it. Corrective measures must be initiated accordingly.

## 4.2 Expense Variances

Expenses are divided into fixed costs and variable costs. The variance between the actual and budgeted fixed costs is obtained simply by subtraction, as these costs are not influenced by market sales or volume of production. But variable costs vary directly and proportionately with the volume.

## **4.2.1 MATERIAL BUDGET VARIANCES**

Material budget variance is categorized as material yield variance. and material usage variance. Material yield variance occurs due to differences between the actual yield and the standard yield. These differences are caused by abnormal loss sustained in different processes of production. Thus, yield variance represents the portion of usage variance that is due to the difference between the standard yield specified and the actual yield obtained.

Material usage variance occurs due to the difference between the standard quantity specified and the actual quantity used. Material usage variance occurs due to the following reasons:

- Careless handling of materials
- Wastage, spoilage, scrap, theft, pilferage, etc.
- Changes in product design, labor, performance, etc.
- Use of inferior materials
- Defective tools and materials
- Setting of improper standards.

## 4.2.2 LABOR BUDGET VARIANCE

Labor budget variance occurs due to the following two factors:

- Differences between actual wage rate and budgeted wage rate.
- Differences between actual labor hours and budgeted labor hours for a particular activity.

The labor budget variance includes wage rates variance and labor efficiency variance. Wage rates are determined through negotiations between the union and the management. This wage rate variance is controllable at the supervisor level. The labor efficiency variance is the difference between the standard labor hours specified and the actual hours spent on work. Labor efficiency depends on the skill levels of the workers, the volume of work hours put in by each worker, and the wage rate. Labor efficiency variance occurs due to the following factors:

- Lack of supervision,
- Poor working conditions in the factory,
- Use of sub-standard materials,
- Inefficiency of workers due to inadequate training,
- Lack of proper tools, equipment and machinery, and
- Higher labor turnover.

## 4.2.3 MANUFACTURING OVERHEAD VARIANCE

Manufacturing overhead variances are the most complicated to compute in the variance analysis. Fixed overhead variance refers to all items of expenditure that are more or less constant, irrespective of fluctuations in the level of the output. This variance represents the difference between the actual cost and the fixed overhead cost. Variable overhead variance represents the difference between the budgeted and the actual variable overheads.

## 5. KEY VARIABLES AND PERFORMANCE MEASURES

A key variable is a significant indicator of business activity, whose sudden and unpredictable change warrants immediate action by the management. Key variables are also referred to as key success factors as they help in explaining the success or failure of the organization. A small change in a key variable will have a significant impact on the performance of the organization. The nature of the task, the technology and the environment in which the organization operates are the factors which greatly influence the identification of key variables. An important function of key variables is that they indicate to the management the necessity for prompt action. A manager should identify a few variables that are crucial to the attainment of strategy, goals and objectives of an organization. Once they have been identified, the manager can rely on these key variables to monitor business activities and alert the organization to the changes in the business environment that could significantly affect the attainment of management goals. The top management should analyze the reasons for significant changes in key variables continually. Some examples of key variables are profitability, market position, productivity and employee attitude.

Four sources which give rise to key variables are:

## 5.1 Characteristics

In a given industry, there are certain general requirements for success, which apply to all the firms. In the insurance industry, for example, the basic requirement for the success of a firm is a positive investment performance. Similarly, in the hotel industry, the occupancy rate is the criterion for success.

The economic and the political climate consist of environmental factors which determine key variables. For example, publishers who depend on postal services are affected by postal rates. The strategy that a company adopts usually determines the variables that must be monitored and emphasized. An organization that follows a low-cost strategy will require an analysis of the product cost structure. Aspects of the business that are important to key stakeholders, namely customers, executives, suppliers or creditors, may also be considered as key variables.

In an organization with a function-based structure, every manager can identify one or a few key variables related to the function of the unit. A key variable for an operations manager, for example, is the quality of goods produced.

# 5.2 Identification of Key Variables

The most common method of identifying key variables is the input-through-output model. The variables are related to raw material, the throughput variables to production, processing and manufacturing, and the output variables to marketing. A generalized list of key variables is given below. However, every organization will have to identify the key variables relevant to its success.

## 5.2.1 INPUT VARIABLES

Key input variables include the following:

- **Raw Material Availability:** This is an important key variable; its absence leads to lower capacity utilization. Organizations find it difficult to recover their fixed costs, when raw materials are not readily available. Inability to procure raw material may even lead to the closure of the organization.
- **Raw Material Quality:** The quality of the raw material is critical for the quality of the end product, and for the profitability of the firm. The quality of raw materials is tested through simple sampling techniques. As payment for a product is made on the basis of quality, the maintenance of quality becomes crucial.
- **Raw Material Costs:** The management needs to keep a close watch on raw material costs, particularly when they constitute a large percentage of the total cost.

## **5.2.2 PRODUCTION VARIABLES**

The key variables related to production are:

- **Capacity Utilization:** Capacity utilization is an important variable and is affected by either marketing variables or procurement variables. For example, in the dairy industry, capacity utilization is affected by milk products sold or by milk procured. Capacity utilization reflects the ability of the production staff to schedule and plan what to produce, how much to produce and when to produce. In service-oriented organizations, it is necessary to decide on the appropriate measures to indicate the utilization of resources. For example, in movie theaters and hotels, percentage of occupancy is an indicator of capacity utilization.
- **Losses:** Another key variable related to production is the percentage of spoilage and wastage in the process of manufacturing the product. In manufacturing industries, the management should monitor the yield percentage closely.
- **Quality Control:** The quality of the product is important for all organizations. Most organizations aim at a zero-defect state. It is necessary to identify the measures of quality. The number of complaints from customers and the quantity of goods returned are usually good indicators of quality.
- **Maintenance:** Maintenance of equipment is crucial to ensure smooth production and better capacity utilization. Maintenance can be categorized as preventive maintenance and breakdown maintenance. The number and percentage of productive hours lost due to maintenance may be selected as a key variable.
- **Costs:** It is essential to control costs as they have a significant impact on profits. Appropriate measures indicating the impact of costs should be developed.
- **Delivery:** Timely delivery is critically important in certain situations. Delays in delivery systems need managerial attention. For example, the production department of a dairy firm has to ensure that the distribution department gets the milk on time.

## **5.2.3 MARKETING VARIABLES**

Marketing variables are of crucial importance in a competitive economy. Some important marketing variables are:

- Order Book Position: The order book position is important for organizations that undertake manufacturing based on orders. It helps the marketing department to decide the planning schedules for marketing and distribution.
- **Market Share:** The market share of a company indicates its performance and its competitive strength. This variable helps the company to monitor its performance.
- **Institutional Sales:** If institutional sales comprise a significant part of total sales, the number of orders received from institutional buyers is a key variable. A decline in institutional sales is a signal of trouble in the marketing area.

## 5.2.4 ASSET MANAGEMENT VARIABLES

The management of fixed and current assets is important for an organization.

**Asset Turnover:** Asset turnover denotes the relationship between the total assets in an organization and sales volume. A decrease in asset turnover is not a good sign for the organization and needs immediate managerial attention.

**Working Capital Turnover:** The efficiency in the management of working capital is indicated by the working capital turnover. The inventory turnover and accounts receivables turnover can also help in the analysis of working capital. A low inventory turnover indicates building up of inventory – an indication that something is seriously wrong in inventory management.

## **5.2.5 TYPES OF VARIABLES**

As discussed earlier, key variables are those activities, functions and business practices that are decided by the market conditions and are considered important for maintaining long-lasting relationship between the customer and the vendor. Key variables are dependent on the skills, processes and systems. The core competencies of an organization must be integrated with the key variables for the growth of the business. This will benefit both the company and the customer. A company must design its business from the market and customer perspective. It should take up those activities and business practices that are revered and which satisfy the needs of the customers. It should also consider those factors which are important in the decision process of the customer and would result in the sale of the product or the service. It should also find out ways and means to attract the customer in face of competition from rivals.

In course of deciding on the above given issues, there are three variable to be considered. The first variable to consider is if the function, activity or business practice has the quality of differentiating the product (or service). If the answer is no, then those activities should be stopped immediately. The second variable is to think and sort the issues that will ultimately result in the completion of business transaction. The third variable is to perform a function, activity or a business practice in a manner which is superior to other competitors and appreciated by the customers.

Control systems designers should thoroughly understand the industry before attempting to identify the key success variables. This includes knowledge of the competition and of environmental forces that have an impact on the industry. In addition, the designer must thoroughly understand the particular company, its culture, and its strategy. Along with this background information, the designer then may use interviews to identify key success factors at each organizational level. After discussing a manager's overall goals, objectives, and strategies, the designer may ask a few critical questions in order to zero in on true key success variables. Designers, who have had extensive experience in identifying key success variables, recommend that the following three questions be asked of managers to identify key success factors:

- The critical factors in the job at the present moment.
- The two or three areas where failure to perform would bring about a loss and where it would be most undesirable if something goes wrong.
- The most important thing, that one would want to know about the business when living in isolation.

# 5.3 Categories of Key Variables

We can classify key variables broadly into categories such as strategy, structural, process and environmental. If there is similarity between the different variables, performance of an organization will improved.

- Strategy variables refer to the long-term choices concerning the programs, goals, policies and action plans that are formulated by an organization.
- Structural variables can be studied in terms of the structure of the organization: centralized or decentralized form of organization and the organizational autonomy. Thus, they represent the organizational arrangements and the distribution of authority and relationships.
- Process variables refer to processes that influence the behavior of the employees towards the achievement of organizational goals. Some examples of process variables are the participation, monitoring and control, human resource development and motivation.
- Environmental variables help in understanding the scope, diversity and uncertainty relating to an organization. The scope of the environment also depends on whether the firm is well diversified or deals in a single commodity. In the case of the former, the scope is broader as the interaction between the organization and the environment is complex.

When all these variables are perfectly aligned then can an organization achieve congruence of its performance with its goals. The following steps will help in the identification of the key variables:

- Identification of decision variables,
- Interactions with the environment,
- Implications for the control structure, and
- Key success and the control paradigm.

#### 5.4 Critical Success Factors (CSF)

The idea of CSF, proposed by Daniel (1961) and popularized by Rockart (1979), is helpful to firms to strategically align the information needs of managers with the business goals. Critical Success Factors are the factors that must be favorable for a business to achieve its targets. These factors make or mar the business or its prospects. That is, the objectives associated with those factors should be achieved lest the business organization would fail and may not recover for a long time. For instance, the CSF for food processing industry are: new product development based on the needs and tastes of the consumers, effective distribution network so that the product reaches the customers in time, no complaints from customers about the quality of the product and effective advertising. CSFs focus on the specific areas of the business. In order to adopt CSF method, there are certain steps that must be followed.

The first step is the identification of the firm's primary mission and the objectives that must be met in order to achieve total and successful performance. The second step is that managers identify the CSFs. Most of the business organizations have very few CSFs and they are decided based on the structure of the industry, the competitive strategy of the firm, the position of the organization in the industry, the geographic location, environmental conditions in which the firm has to operate and the opportunities and threats for the firm. For instance, for a firm in a service industry the CSFs are improving customer relationships, utilizing human resources efficiently and effectively, bringing out new products and services periodically etc. The third step involves the identification of indicators or measures of performance for each CSF. For instance, customer relationship can be measured in terms of ratio of number of customers who make inquires to the actual customer orders received, number of new customers added during a particular period, timely delivery, etc., In the fourth step, the important measures are identified and Information Systems (IS) are geared up to collect and utilize this information.

The decision to fix CSFs is taken with broad consensus based on what is most important or critical to the company. Thus, a good communication is established among the executives who help in prioritizing the things that need to be done to achieve the objectives. CSF method should be applied with due care taking into account the important shortcomings of the company. It is more effective when taken by the top management team who can achieve compatibility between strategic goals and the CSFs.

## 5.4.1 IDENTIFICATION OF DECISION VARIABLES

Decision variables refer to those key success factors which are subject to manipulation through a conscious decision-making process. The identification of decision variables is very crucial for an organization as they directly or indirectly influence the goals and strategies of the organization. Roger Hall has identified five decision variables for a publishing company.

- a. The annual subscription rate.
- b. The price charged for advertisers for each page of advertising copy.
- c. Annual expenditures for the promotion of subscription sales.
- d. Annual expenditures for the promotion of advertising sales.
- e. The volume of the magazine (i.e., pages per issue).

Hall assumed that three variables (profit, circulation, and advertising revenues) are used by the management to judge the performance of the magazine. To summarize, decision variables are those key success factors which help the management to choose a particular course of action and execute it promptly.

## **5.4.2 INTERACTIONS WITH THE ENVIRONMENT**

To identify key success factors, environmental variables are to be identified. Roger Hall has found four critical relationships in a magazine publishing firm, which interact with the environment.

The first relationship specified the demand for advertising pages, the second, the demand for regular subscriptions, the third is concerned with the sales and subscriptions and the last is concerned with the total cost of producing the magazine. The most important environmental factors that influence the identification of key variables in an organization are the economy and the political climate.

## **5.4.3 IMPLICATIONS FOR THE CONTROL STRUCTURE**

Important parameters on the basis of which the control structure can be chosen are:

- i. Efficiency and effectiveness,
- ii. Economies of scale,
- iii. Problems of coordination,
- iv. Assignment of profit responsibility, and
- v. Conflict of profit responsibility.

The control systems prefer a divisional structure in an organization, because within a division, the departments are organized on a functional basis.

Let us again take the example of a publishing firm. The divisional structure for a publishing firm would be as follows:

For a publishing firm, quality of editing is crucial. The editor, thus, has a significant influence over the quality variables, as well as the long-term future of the business. The implications for a control structure are largely dependent on the divisional structure of an organization. Each responsibility center would then play an important role in achieving the overall goals of the firm. Thus, each success factor becomes a goal for various responsibility centers.

## 5.4.4 KEY SUCCESS VARIABLES AND THE CONTROL PARADIGM

The hierarchical structure of an organization gives an equal chance to process all the information pertaining to key success factors, and to make business decision. Through decentralization, the management gives a degree of autonomy in decision making to subordinates. The control system designers establish critical success factors that help managers achieve their subunit goals. Each unit and subunit of hierarchical structure should coordinate and control the various key success factors in pursuit of overall goals of the firm.

The multivariate statistical technique of factor analysis can be used in identifying the key factors underlying organizational variables. Multivariate analysis helps in identifying the critical control variables and latent factors. It helps in identifying a wide range of key variables which help in analyzing a particular situation and initiates prompt actions. Factor analysis can be helpful in identifying the organizational variables which are latent, yet contribute to the success of the organization and it relies heavily upon the data availability.

The motive behind using multivariate analysis for the identification of key variables is to confirm the accuracy of the key variables and the collection of the data required to identify them. The main advantage of this analysis is that it can help an organization to relocate the latent factors that play an important role in the identification of key variables. Multivariate analysis can be applied to identify the critical control variables and underlying factors in the field of management control.

## 5.4.5 MULTIVARIATE ANALYSIS AND KEY VARIABLES

The multivariate statistical technique of factor analysis can be used in identifying the key factors underlying organizational variables. Multivariate analysis helps in identifying the critical control variables and latent factors. However, readymade computer programs are available for various multivariate techniques. This has made factor analysis a popular exploratory technique.

Multivariate analysis helps in identifying a wide range of key variables winch help in analyzing a particular situation and initiates prompt actions. Factor analysis can be helpful in identifying the organizational variables which are latent, yet contribute to the success of the organization. Factor analysis relies heavily upon the availability of data. The rating scales and graphic representations make the work of factor analysis easier through systematic classification and graphic representation of data.

Factor analysis results can be applied in three ways:

- i. To reveal the latent factors that directly or indirectly influence the observed data.
- ii. To make evident the relationship between the data that had been latent before the analysis and the observed data obtained during the analysis.
- iii. To provide a classification scheme, the data recorded on various rating scales have to be grouped together.

The motive behind using multivariate analysis for the identification of key variables is to confirm the accuracy of the key variables and the collection of of the data required to identify them. The main advantage of multivariate analysis is that it helps a firm to relocate the latent factors that play an important role in the identification of key variables. Multivariate analysis can be applied to identify the critical control variables and underlying factors, in the field of management control.

# 5.5 Comprehensive Performance Indicators

Every organization needs to identify the variables that influence its success at each level so that it can monitor and predict the values of key variables. The main idea of monitoring the performance of key variables at each level of the organization is to push them to the desired level and, if that is not possible, to react to the performance of the key variables so as to balance their impact. Key variables should be identified at each level and for each responsibility center of the organization.

The measurement of key variables is not free from problems. One danger is that of concentrating on the variables that are easy to measure. Variables which are difficult to measure but which are important to the achievement of long-term goals are often ignored. For example, firms often emphasize short-run profits and encourage managers to produce (production in term of quantity), regardless of the long-term effects on the business. This results in the reduction of expenses on research and development, maintenance, and employee development which may not affect the performance in the short-run, but plays a significant role in the accomplishment of long-term goals. A number of precautions have to be taken with regard to the measurement of performance in any responsibility center. First, the variables that are measured should correspond with the goals and objectives of the organization. Second, only those variables that are crucial should be measured, and they should be measured even if they are qualitative. Key success factors should not be omitted from the control system because they are qualitative. Third, the measurement of the factors should be developed in such a way that the measures taken in the short term take account of both short-term objectives and long-term goals. The process for measurement of key performance variables can be observed by looking at the case of General Electric. General Electric (GE)
Management Control Systems and Managerial Controls

divided the task of measuring key success factors in the company into three subprojects which involved developing performance measures for each of the company's departments. The exercise focused on:

- Measuring the whole department as an economic entity.
- Measuring the functional departments such as marketing, finance etc.
- Measuring the performance of the management of the departments.

On the basis of the above measures, the principles for the control program at GE were formulated. The principles focused on providing:

- Factual knowledge to support judgment in the performance of departments.
- Performance information for both short-run as well as long-term goals.
- The minimum number of measures for use at each level of the organization.

GE developed the following performance measures for each of its departments:

- i. Short-term profitability,
- ii. Market share,
- iii. Productivity,
- iv. Product leadership,
- v. Personnel development,
- vi. Employee attitude,
- vii. Public responsibility, and
- viii. Balance between short-range objectives and long-range goals.

### 5.6 Limitations of Indicators

Indicators are used to understand an organization's current state of affairs and for initiating corrective action. However, there has to be consensus on what the indicator really means and conveys.

Performance indicators have the following limitations:

- The absence of consensus among managers on the use of indicators.
- Problems encountered during the measurement of indicators.
- Lack of clear specification of the indicators of measurement.
- Lack of consistent information leading to incorrect conclusions.

These limitations can be overcome by developing systematic and scientific methods to improve the quality of the data on which decision-making is based.

# 5.7 Critical Success Variables in Selected Industries

Given below are some important critical variables in various industries. They illustrate how key variables or key success factors play an important role in day-today operations.

**Insurance Industry:** In an insurance industry, the key variables are number of claims settled in a given period of time, number of claims outstanding, the number of policies processed in a given period of time, and growth rate in insurance business with respect to each policy.

### **Hotel Industry**

- a. Room occupancy rate.
- b. Number of complaints by customers.
- c. Amount of food wasted in the restaurant.
- d. Percentage of revenue contributed by the restaurant.
- e. Percentage of absenteeism among employees.

### Sugar Industry

- a. Price of sugar sold in the open market,
- b. Transport cost per ton of cane,
- c. Fuel cost per kilogram of sugar,
- d. Number of production days lost, and
- e. Support price by the government.

### **Management Training Institute**

- a. Number of students appearing for an entrance examination.
- b. Percentage of absenteeism among students.
- c. Number of research projects undertaken and completed.
- d. Time spent by faculty on teaching and research.
- e. Time spent on management development programs.
- f. Percentage drop out.

**Power Industry:** The inputs for a power industry are coal and water. The output variables include transmission losses. The key variables include the following:

- a. Quantity and quality of coal,
- b. Availability of wagons for transportation of coal,
- c. Availability of water,
- d. Capacity utilization, and
- e. Preventive and breakdown maintenance.

# SUMMARY

- Management Control System is a plan for the procurement of resources and their use in an efficient and effective manner in order to reach the goals set for an organization. It assists the management in the synchronization of the activities of the organization and steering them in the proper direction so that the organization is able to move along the developmental path.
- The role of management is to plan, organize and integrate organizational activities for the achievement of organizational objectives. This role is facilitated through management control systems.
- Methods and procedures play an important role in the exercise of management control. Management control encompasses planning, organizing, directing, and controlling program operations.
- A control system is a set of formal and informal systems to assist the management in steering the organization and its employees towards its goals.
- Control systems help in the effective implementation of an organization's strategy. The subsystems and components of management control systems should be mutually supportive so that organizational goals can be achieved.
- Formal controls are laid out in writing by the management, whereas informal controls arise as a result of employees' behavior. Examples of formal controls are plans, budgets, regulations and quotas. Informal controls include group norms and organizational culture.
- The formal planning process has two dimensions: strategic planning and operations planning. In most organizations there are two budgets one for operations and one for strategy; and, there are two sets of reports one for strategic projects and one for operating activities.

- Informal control systems promote greater compatibility and encourage the desire of the members to serve the organization to the best of their capabilities.
- Like formal control systems, an informal control system contains the subsystems such as recognition and rewards, informal coordinating mechanisms, style and culture and informal control process.
- Management style and corporate culture play an important role in designing the control system. While management style is related to the individual manager, corporate culture relates to the overall organizational concept.
- Corporate culture consists of shared values, common perceptions and common premises that the members of an organization use to achieve goals. Organizational culture influences several basic premises of an organization and, hence, has a major influence on the organizational goals.
- Key variables are those variables to which the goals, strategies and objectives of the management are most sensitive. Every organization should identify the key factors which are important for its success.
- Key variables are also referred to as key success factors as they help in explaining the success or failure of the organization. A small change in a key variable will have a significant impact on the performance of the organization.
- The most common method of identifying key variables is the input-throughoutput model. The input variables are related to raw materials and other inputs, the throughput variables to production, processing, manufacturing, and the output variables to marketing.
- In an organization with a function-based structure, every manager can identify one or a few key variables related to the function of the unit. A key variable for an operations manager, for example, is the quality of goods produced.
- Key variables can be classified broadly into the following categories: strategy, structural, process and environmental. Strategy variables refer to the long-term choices concerning the programs, goals, policies, and action plans that are formulated by an organization. Structural variables thus represent the organizational arrangements and the distribution of authority and relationships. Process variables refer to the processes that influence the behavior of the employees towards the achievement or organizational goals. Environmental variables help in understanding the scope, diversity and uncertainty relating to an organization.
- Critical Success Factors are the factors that must be favorable for a business to achieve its targets. These factors make or mar the business or its prospects.
- Multivariate analysis helps in identifying a wide range of key variables which help in analyzing a particular situation and initiate prompt actions.
- Factor analysis can be helpful in identifying the organizational variables which are latent, yet contribute to the success of the organization. Factor analysis relies heavily upon the availability of data.

# <u>Chapter V</u> Decision Support Systems: An Overview

# After reading this chapter, you will be conversant with:

- Decision-Making Process
- Types of Decisions
- Introduction to Decision Support Systems
- Group Decision Support Systems
- Basic Components of Decision Support Systems
- Facilitating Problem-solving and Aid for Non-Structured Problems

### **Decision Support Systems: An Overview**

Management Information Systems (MIS) caters to the information needs of managers. MIS provides a broad range of information on a firm's performance to help managers to monitor and control business activities. The reports that MIS produced are mostly of fixed format and are scheduled regularly on the basis of the data extracted and summarized from the organization's Transaction Processing Systems (TPS). Some MIS reports may highlight exceptional conditions arising in any functional area of the business which requires managerial intervention. The business organizations across the world are exposed to rapidly changing business environment driven by technology, the emergence of multinational companies with branches throughout the world, and the increased competition therefore, today's managers require special category of information systems that are uniquely designed to effectively enhance decision-making process. These information systems are special in the sense that they are designed to provide different alternative organizational scenarios, to take strategic decisions, produce precise firm-wide information and provide tools to facilitate group decision-making process based on the unique business needs of the managers. For instance, these information systems can automate certain decision procedures, provide information about different aspects of the situations which require decision-making, and also provide information about new opportunities of business and possible solutions to the problems by analyzing the data with the help of specialized software and statistical packages. Some examples of such information systems are Decision Support Systems (DSS), Group Decision Support Systems (GDSS), Executive Information Systems (EIS) etc. The study of DSS is an applied concept that makes use of theory and knowledge from other disciplines.

Organizations are required to collect data, convert it into information and process that information. Based on that information, they are required to make decisions and then implement them in order to achieve organizational objectives. Since today's organizations are global in their outlook, they have to consider many variables in the ever-changing business and technological world. Information Technology (IT) has come to the aid of decision-makers. The developments in the field of computers, communications and IT have changed the way organizations perform their decision-making activities. DSS was computerized and had practical applications with the development of minicomputers, timeshare operating systems and distributed computing.

DSSs have become prominent tools for organizations, using which the latter could enhance their decision-making capabilities. Previously organizations had predefined and static set of goals. But globalization, has increased manifold the competitive sprit. Thus, to survive in today's dynamic environment, organizations must be able to quickly and effectively respond and adapt to changes in their business settings. The changes are a result of varying customer demands, competitive forces, changes in labor laws and patterns, environmental and political concerns, social awareness, security concerns and others. The advancement in the field of DSS has led to the development of different forms like Expert Systems (ESs), intelligent DSSs, active DSSs, and adaptive DSSs. The concepts and principles of Artificial Intelligence (AI) have also been included in the design of DSS applications, thus enhancing their capabilities. In this chapter, we shall study in detail the DSSs, their types, characteristics and advantages. Before studying about DSSs, we shall consider the various steps involved in the decision-making process.

### **1. DECISION-MAKING PROCESS**

Decision-making is a systematic process and involves a series of steps. Any decision-making process consists basically the following seven steps:

i. **Identifying the Problem:** The first step in the decision-making process is the identification of a problem. Prior to identifying the problem, it is essential to first recognize that a problem exists. Identification of the problem involves three stages: scanning, categorization, and diagnosis. The scanning stage

involves monitoring the work environment for changes that may indicate the emergence of a problem. At this stage, a manager may have a very faint idea that an environmental change could lead to a problem or that an existing situation is posing a problem. When an organization fails to achieve its goals, there is a performance gap between the predicted or expected level of performance and the actual performance level. The categorization stage attempts to understand this performance gap. At this point, the manager attempts to categorize the situation as problematic or not. The diagnosis stage involves gathering relevant facts and other additional information pertaining to the problem. It also specifies both the nature and the causes of the problem. At this stage, the problem should be stated in terms of the discrepancy that exists between the current conditions and the desired conditions, and the causes for the discrepancy should also be specified. Proper diagnosis is very essential for the success of the decision-making process.

- ii. Resources and Constraints: Once the problem is identified and diagnosed, the manager should identify the resources and constraints relevant to the problem. Anything that can be used to solve the problem is a resource. These include people, money, materials, time, equipment, expertise, and information. On the other hand, constraints are the factors that limit managers' efforts to solve the problem. They are hindrances to problem solving. Examples of constraints include lack of adequate resources, etc. Organizations generally face more than one problem at a time. These problems compete for the manager's attention and for the scarce resources of the organization. Making an explicit list of the organization's resources allows the manager to allocate the resources in such a way that they are utilized to the maximum extent possible. The listing of constraints alerts managers to the presence of various bottlenecks that could create problems. Organizations sometimes face situations in which the absence of a specific resource or the presence of a particular constraint poses a problem for conducting its business.
- Generating Alternative Solutions: Once the problem, resources and iii. constraints of the organization are identified, the next step would be to generate feasible alternatives to the problem. Managers should not take any major decisions without exploring all the possible alternatives. The temptation to accept the first feasible alternative often prevents managers from finding the best solution to the problem. Generating a number of alternatives allows them to resist the temptation of finding a speedy solution to the problem and increases the chances of reaching an effective decision. The development of alternatives can often be facilitated through brainstorming, a group decision-making technique that encourages members of a group to generate as many feasible ideas as possible on a given topic, without carefully evaluating each one of them. In a brainstorming session, none of the ideas offered is criticized. Each idea is recorded for later evaluation. Since there are always alternatives waiting to be discovered, the process of generating alternatives could go on forever. Two factors must be taken into consideration when determining the appropriate amount of time to be spent on generating alternatives. The first is the importance of the problem. The greater the importance of the problem, greater will be the value of any improvements that can be made to the solution of the problem. The second factor relates to how accurately the manager is able to differentiate among alternatives. This depends on the availability of data and the cost of evaluating the data. When sufficient data is available, it is relatively easy to distinguish between alternatives and to determine their relative effectiveness. Managers should not devote too much time to generating alternatives when the data available is very limited. Similarly, a manager prefers fewer alternatives when the cost of evaluating the data is high.

### Decision Support Systems: An Overview

- iv. Evaluating Alternatives: The generation of alternatives should be followed by a thorough analysis of the pros and cons of each alternative. In other words, alternatives should be evaluated in order to see how effective each would be. Generally, there are five criteria on the basis of which alternatives are evaluated: feasibility, quality, acceptability, cost, and ethics. Feasibility refers to the degree to which an organization can accomplish a particular goal within the related organizational constraints (such as time, budget, technology and policies). Alternatives that do not seem feasible should not be considered any further. Quality refers to the extent to which an alternative finds an effective solution to the problem under consideration. Alternatives that only partially solve the problem are eliminated at this stage. Acceptability refers to the degree of support extended to the chosen alternative by the decision-makers and those who would be affected by its implementation. This criterion is considered to be very important in evaluating alternatives. The costs criterion refers to the resources required and also the degree to which the alternative may produce undesirable side effects. Thus, the term "costs" not only includes monetary expenditures that the company incurs but also some intangible issues such as retaliation from competitors. Ethics refers to the degree of compatibility of an alternative with the ethical standards and social responsibilities of the organization.
- Selecting an Alternative: After evaluating the alternatives, the next step in v. the decision-making process would be to select the best alternative. Managers can make use of three basic approaches for selecting among alternatives. These are: (a) experience, (b) experimentation, and (c) research and analysis. When taking decisions, managers tend to rely on past experience to a great extent. Many managers believe that their previous accomplishments and mistakes are infallible guides to the future. Though experience is the best teacher, excessive reliance on it can be dangerous, especially since many managers fail to recognize the underlying reasons for their mistakes or failure. Moreover, the solutions to new problems may be very different and the lessons from one's experience may not be valid in every situation. For one to take good decisions, these have to be evaluated in terms of the future. Experience can be useful only when the decision-maker learns the fundamental reasons for success or failure from experience. A successful program, a profitable product promotion, or any other decision that turns out well, may provide avenues for such learning. Another way to decide among alternatives is to try one of them and see the consequences. Experimentation is often used in scientific inquiry. Most people recommend that it should be employed more often in managing and that it should be the only way by which a manager can make sure that the plans are right. The experimentation approach can be quite expensive, especially if a program requires heavy capital expenditure, and if several alternatives have to be tried out. Moreover, after experimenting, doubts may still linger as to what the experiment proved. Thus, this technique must be used only after considering other techniques. Experimentation can, however, be used in other ways. For instance, a firm may test a new product in a certain market before launching it nationwide. Organizational techniques are often tried out in a branch office before being implemented throughout the company.

When important decisions are involved, one of the most effective techniques to select an alternative is through research and analysis. This approach attempts to solve a problem by first understanding it. It tries to find relationships among the critical variables, constraints, and premises which have a direct effect on the goal to be accomplished. In this approach, the decision-maker develops a model simulating the problem. He may also represent the variables in a problem situation through mathematical terms and relationships. One of the most comprehensive research and analysis approaches to decision-making is operations research. This is discussed later in the chapter as one of the decision-making techniques.

Whatever approach the decision-maker may adopt in selecting an alternative, he must bear in mind that the selected alternative should be acceptable to those who must implement it and those who will be affected by the decision. Failure to meet this condition is one of the most likely reasons for failure of the decision-making process.

Implementing the Decision: After selecting the best among the available vi. alternatives, it must be implemented earnestly to achieve the objective. It is possible for a good decision to become ineffective due to poor implementation. Successful implementation of a decision usually depends on two factors - careful planning, and sensitivity to those who will implement the decision and/or those who will be affected by it. Minor changes require only a little planning, whereas major changes require extensive planning efforts, such as written plans, special funding arrangements, and careful coordination with units inside and outside the organization. Decisions can be implemented smoothly by being sensitive to the reactions of those whom the decision will affect. The decision-makers should anticipate potential resistance at various stages of the implementation process. They should also realize that unanticipated consequences may arise despite the fact that precise evaluation of all alternatives and careful consideration of the consequences of each alternative have been undertaken.

After the process of implementing the decision has begun, any number of situations, such as unexpected effects on cash flow or operating expenses, can arise. Managers must, therefore, have contingency plans ready to deal with such situations. In order to overcome resistance to change, the people who will be implementing the decision should be given careful orientation and training. A participative approach may be an effective way for the successful implementation of certain decisions. Most managerial problems require the combined efforts of many members of the organization; each should understand what role he or she is to play during each phase of the implementation process.

vii. Monitoring the Decision: Managers are required to monitor the process of implementation of the decision so as to make sure that everything is progressing according to plan. They should also ensure that the problem that initiated the decision-making process has been resolved. Monitoring decisions involves gathering information to evaluate how the decision is working. Thus, feedback is an essential component of the decision-making process. It allows the decision-maker to determine the effectiveness of the chosen alternative in solving the problem or in moving the organization closer to the attainment of its goals. In order to evaluate the effectiveness of a decision, there should be a set of standards against which actual performance can be compared. A second requirement is the availability of performance data for comparison with the set of standards. Finally, a data analysis strategy, which includes a formal plan outlining how the data will be used, should be developed. By reviewing the decisions, the decision-maker will recognize the mistakes he has made and learn where and how to avoid them in the future. This will also help him sharpen his decision-making skills.

# 2. TYPES OF DECISIONS

Following are the three types of decisions:

. **Structured Decisions:** For taking these types of decisions, there are a set of rules and procedures that need to be followed. The rules and procedures ensure that the outcome of the decisions is well-known in advance. If the outcome is different then it means that the rules and procedures have not been followed properly. These types of decisions are routine and repetitive under a given set of conditions. The examples of this type of decisions are related to production, accounts receivable, payroll, budget analysis, inventory management etc. In these types of decisions, there is no or very little alternative choice for the decision maker to take alternative decisions. The use of MIS is very useful in taking structured decisions.

- ii. Unstructured Decisions: There are no readymade decisions for unstructured problems. Most of the time unstructured decisions are made on the basis of manager's intuition and experience. Expert systems are used to make unstructured decisions. There are no preplanned rules and procedures for making unstructured decisions. Strategic planning decisions come under these types of decisions. Even line managers have to make unstructured decisions when dealing with workers and bosses.
- iii. Semi-structured Decisions: In some types of decisions it is not possible to put in place a particular set of guidelines for taking a decision. However, the guidelines are specified in general terms. Such decisions are termed as semistructured. For taking decisions of semi-structured type, there is a combination of both standard procedures and also an element of individual experience and skill. Decision Support Systems (DSSs) can be used for taking semi-structured decisions.

## **3. INTRODUCTION TO DECISION SUPPORT SYSTEMS**

One of the most prominent concepts in the field of Management Information Systems is the DSS. They come under the third generation of computer-based applications. DSSs are interactive, computer-based information systems that use decision models and specialized databases to assist decision-making processes of managerial endusers. The important users of DSS are business executives or some other group of knowledge workers. They are designed to provide endusers, who are usually managers, with information in an interactive session as and when they require it. The capabilities provided by DSS are analytical modeling, simulation, data retrieval, and information presentation capabilities. DSS assists managers in the process of making unstructured decisions by providing information and alternatives based on sets of assumptions in an interactive and simulation-based process.

For instance, a decision support application might gather and present information relating to the comparative sales figures between one week and the next, and project revenue figures based on the assumptions of the sale of a new product. In another instance, electronic spreadsheets and other decision support software allow managerial personnel to seek alternative solutions based on what-if questions. The response from the DSS will be interactive for such ad hoc questions. A decision support system may present information graphically and may include an expert system or Artificial Intelligence (AI). DSS is more focused than Management Information Systems.

The purpose of a DSS is to improve decision-making ability of managers and operating personnel by generating alternatives which take into consideration the constraints of human cognition, time and economic limits. It helps in increasing the productivity of decision makers by assisting in the collection of data (knowledge), formulation of potential plans for analysis or action, analysis and derivation of conclusions in the form of what if, what about and what follows and also recognition of a problem or multiple problems and combining solutions to the problems. DSS also facilitates the decision-making phases of Intelligence (i.e., provide relevant information), Design (i.e., identify or analyze alternatives) and Choice (i.e., advice about which alternative to choose).

# 3.1 Definition

The following are the various definitions of DSS:

- i. A Decision Support System (DSS) is a computer program application that analyzes business data and presents it such that users can make business decisions more easily.
- ii. A computer system that combines data, analytical tools, user-friendly software to support decision-making at the management level.

- iii. DSS are interactive, well-integrated systems that provide managers with data, tools, and models to facilitate semi-structured decisions or tactical decisions.
- iv. A DSS is a type of Intelligent Support System (ISS) that integrates internal and external data with various decision-making models in order to produce alternative solutions to a given problem.
- v. A DSS is a set of well-integrated, user-friendly, computer-based tools that combine data with various decision-making models (both quantitative and qualitative) to solve semi-structured and unstructured problems.
- vi. Decision Support Systems (DSSs) are a specific class of computerized information system that supports decision-making activities.

### 3.1.1 DSS CLASSIFICATION

Alter made an extensive study on Decision Support Systems that could be used in organizations. According to him, DSS can be divided into seven major groups. These groups are:

- File Drawer Systems For accessing data items.
- Data Analysis Systems For ad hoc analysis of data files.
- Analysis Information Systems For ad hoc analysis using databases and small models.
- Accounting Models Estimating future results based on accounting rules.
- Representation Models Estimating results and consequences where there is a possibility of risk.
- Optimization Models Calculating optimal results where one encounters limitations.
- Suggestion Models Producing suggested results where decision rules are known.

# 3.2 Characteristics of DSS

- DSS facilitates semi-structured and unstructured decision-making by coordinating data, models and human judgment.
- DSS assists managers and Decision Makers (DMs) in situations where several interdependent decisions are to be made. DSSs are not intended to replace DMs.
- DSS supports a wide variety of decision-making processes and styles.
- DSS assists managers/decision-makers in the rapidly changing circumstances of business environment by focusing on the effectiveness of the decisionmaking process rather than its efficiency.
- DSS assists managers by providing analytical tools, data, and a collection of mathematical and analytical models. In addition, it provides an interface to the user in the form of user-friendly software. Managers working at all the levels in an organization can satisfy their ad hoc queries with the help of DSS.
- DSS is under the control of the users and facilitates learning on the part of the decision-maker by being interactive and user-friendly.
- DSS is generally developed using an evolutionary and iterative process.
- DSS can provide support for multiple independent or interdependent decisions in the context of individual, group and team-based decisions.
- DSS assists decision-making in all its phases: intelligence, design, choice and implementation.

- DSS is flexible in the sense that the decision-makers can add, delete, modify or combine basic elements. Various knowledge management techniques can be incorporated in DSS.
- Using DSS, the decision-maker has total control over all the steps leading to the final decision. The aim of the DSS is to assist but not to replace the decision-maker. The final choice of the alternative decision is with the decision-maker.
- A DSS makes use of a number of models for analyzing decision situations. The models assist in conducting the experiments to find out the consequences of various decisions and thus develop appropriate strategies.
- There are many types of DSS. Some are simple that can be constructed by an individual while large and complex DSS are constructed by groups of individuals.

# 3.3 Working of DSS

DSS accesses and processes large volumes of internal and external data and makes it available to various decision-making models. Internal data is collected from internal sources like Transaction Processing System (TPS) or from other information systems. Such data is often downloaded from mainframe computer and provided to smaller systems such as a PC. External data may come from various journals, stock market publications and economic survey reports or from databases maintained by government or private agencies. Alternate solutions are provided by utilizing this data as an input variable by mathematical, analytical, physical or conceptual models to produce alternate solutions to a problem. Some examples of models include calculating mortgage payments, determining overall course grades, assessing the amount of air pollution and predicting cyclones, and population growth.

Following are the four basic types of analytical modeling activities that can be performed using DSS. They are:

- i. What-If Analysis: What-If Analysis helps in analyzing the alternatives generated by the models. This analysis is used to determine the impact of changes when inputs or outputs are increased, decreased or changed. For example, in order to fix the selling price of a product, a number of factors like raw material cost, labor cost, taxes, competitors prices, product demand, consumer income, etc., have to be taken into account. Changes in some or all of these factors can produce alternative selling prices for a given product with the help of DSS. Thus, the manager can compute the selling price if there is X% change in the price of raw materials or can change the selling price if the consumer income increases by Y%. This type of analysis can be repeated until the manager is satisfied with the results revealed about the effects of various possible decisions.
- ii. **Sensitivity Analysis:** It is the special case of what-if analysis. Even though a number of variables affect a given situation, in this case only one variable is changed a number of times to determine the effect of change each time on other variables. Some DSS packages are loaded with the facility of sensitivity analysis. Thus, they automatically make repeated small changes to a variable at a time when asked to perform sensitivity analysis. Sensitivity analysis is used when decision-makers are uncertain about the assumptions made in estimating the value of certain key variables. For instance, if revenue and tax are the two variables which affect profit after tax, then the decision-maker may be interested to know the effect of change in revenue on the amount of tax to be paid.
- iii. **Goal-Seeking Analysis:** Another function of DSS is that it allows managers to perform goal seeking. Under goal seeking, DSS specifies the actions which a manager should take in order to accomplish a certain goal. Suppose the goal

of the marketing manager is to increase the quantity of sales by 20%, then DSS can assist the manager regarding the course of action to be taken to achieve this goal like reducing the selling price, changing the brand ambassador, using a different channel for advertisement or any other related issue. Another example is that if the goal of the principal of a professional college is to increase the intake of students then DSS can assist him regarding the course of action to be taken like reducing the fees or the changes to be made in the syllabi to facilitate more interaction with industry. The variables involved in reaching the goal are repeatedly changed until the desired goal is achieved.

iv. **Optimization Analysis:** It is a complex extension of goal-seeking analysis. Instead of setting a specific target value for a variable, the goal is to find the optimum value for one or more target variables, given certain constraints. Like in goal-seeking analysis, the goal or target is fixed and the changes in the variables affecting the goal or the target are also made. But the changes to the variables are made subject to constraints. For instance, the profit target is fixed and the changes to the revenue are made repeatedly until the target is reached. But changes made to the revenue are constrained by the production capacity of the firm.

# 3.4 Core Capabilities of DSS

The major capabilities of DSS are as follows:

- i. **Representations:** A DSS is capable of presenting information in the form of graphs, charts, lists, reports, formatted reports, symbols, etc. This information can be used to control the activities of the organization so that they are within the range set by the management.
- ii. **Operations:** With DSS, logical and mathematical operations can be performed on the data that is collected from various sources. Typical operations include, data collection, generating statistics, preparing reports, determining risks and assigning values, and performing simulation operations to generate alternatives.
- Memory Aids: DSS provides facilities for updating databases and memory, viewing of data, work spaces, libraries and linkages among libraries and work places.
- iv. **Control Aids:** A facility is provided to the user for controlling the activity of DSS. The DSS operations, memory and representations can be controlled. There are tutorials, help commands and function keys that help the user in understanding DSS and effecting the required changes.

# 3.5 Advantages of Decision Support System (DSS)

The advantages of DSS are as follows:

- DSS finds its application in forecasting, demand management, and supplier evaluation. DSS can help in putting data gathered from a number of sources and use it to forecast the appropriate quantity of input resources to produce goods, to predict consumer demand and determine the equilibrium quantity of demand and supply of goods.
- DSS can also provide information regarding competitors' strengths and weaknesses.
- DSS can provide comprehensive data to the managers regarding the different projects of the company, its programs and products. This data helps in taking appropriate decisions.
- DSS can help companies to evaluate prospective suppliers based on the given standards which they (suppliers) have to satisfy and also select the best out of them.

- DSS helps in corporate planning, developing effective advertisement strategies, determining optimal input raw materials for producing output, fixing appropriate selling price for the products, and selecting investment portfolios based on the risk return preferences of the investors.
- DSS is simple to use by analysts.
- DSS integrates data collected from different resources. It can process large volumes of data which is beyond the capability of manual processing. It can perform ad hoc analysis and satisfy ad hoc queries of managers.
- DSS provides multiple alternatives or solutions to the decision-maker and helps him to choose that alternative which maximizes expected returns. This helps in understanding the business environment in a great detail.
- DSS helps to solve interrelated and inter-organizational problems. It helps managers to make semi-structured and unstructured decisions.
- DSS helps decision-makers to control deviations of actual results from the expected results, since there is an improvement in taking informed decisions and communicating the results.

## 3.6 Disadvantages of Decision Support System (DSS)

Some of the disadvantages of DSS are as follows:

- Requires computer skills to obtain results.
- Requires preparation and analysis time to get desired information.
- Provides detailed analysis of a given situation.
- Difficult to quantify benefits of DSS.
- Difficult to maintain database integrity.
- Provides only moderate support of external data and graphics capabilities.
- DSS is not capable of replicating many of the human knowledge management skills or talents.
- Many DSSs are too specific that cannot be used in different situations.
- It is possible that DSS may not match decision-maker's mode of expression or perception.
- DSS cannot overcome or rectify a faulty decision made by a decision-maker.
- DSS is limited by the knowledge that it possesses. It is not possible to judge the extent to which a DSS can learn.
- There is a possibility that there would be an excessive reliance on the DSS, resulting in the erosion of human intuition.
- The language and command interfaces used in DSS are not well-advanced so as to facilitate natural language processing of the instructions issued by the users.

### 4. GROUP DECISION SUPPORT SYSTEMS

DSS can be used by either a single person or a group of persons. When DSS is used by a group of persons in decision-making process, then it is known as Group Decision Support Systems (GDSS). A Group Decision Support System (GDSS) can be defined as an interactive, computer-based system that helps a team of decision-makers solve problems and make choices. A GDSS system can also be defined as an interactive, computer-based system that facilitates solution of

unstructured and semi-structured problems by a set of decision-makers working together as a group. GDSS assists people who are involved in analyzing problematic situations and also in group decision-making tasks. GDSS is particularly useful in large organizations where the top management team a group take decisions collectively on sensitive matters. For instance, in companies the board the directors consisting the chairman, managing director and other executive and non-executive directors collectively takes decisions in the matters which are in the interest of shareholders and the company. Hence, to facilitate such an interaction, GDSS has an elaborate communications infrastructure and heuristic and quantitative models to support decision-making.

In a traditional decision-room based GDSS, there is a decision room with workstations for participants. The decision room is a physical arrangement which enhances and improves the decision-making process of the participants. The characteristics of decision room are:

- i. Each participant is provided with a computer work station.
- ii. A network linking all the computers and client/server architecture is used.
- iii. A special type of software is made available to all the participants which aids in decision-making.
- iv. A leader (coordinator) is present to facilitate the meeting.
- v. The decision room has a display screen which the participants can view.

GDSS offers many advantages for business organizations. In today's competitive business world, the complexity of decisions a management has to take is increasing in manifold due to increase in the group of variables available to be considered. Thus, a single individual or a very small group of individuals cannot take decisions for multinational companies sitting in the board room. Opinion of a number of executives working in different geographical locations has an important bearing on the quality of the decision.

Thus, with GDSS it is possible to gather information and ideas from managerial staff without any constraints of geographical locations, place or time. For example, a university professor can impart business skills to a group of executives of a company who are located in another country without the need to travel to their place. In another instance, a multinational company involved in the manufacture of chemicals can arrive at common decisions by bringing together chemical experts and sales people with GDSS though they may be at different locations across the world.

### 5. BASIC COMPONENTS OF DECISION SUPPORT SYSTEMS

Following are the basic components of DSS:

- The data management system.
- The model management system.
- The knowledge engine.
- The user interface.
- The users.
- It is essential to know the details of these basic components of DSS in detail:

### 5.1 The Data Management System

For making a decision, the data management system brings to light the relevant data, stores it and also organizes it. For making a decision through DSS, which is relevant and has quality, it is necessary that the quality and structure of the database needs to be maintained. A database arranges in a logical order on the basis of granularity of the data.

The logical order of the data in the database has four elements:

Following is the logical Organization of data in information systems:

- i. **Character:** It is the most basic logical data element that consists of a single alphabetic, numeric or other symbol. This logical data element can be observed and manipulated. It occupies a single basic or elementary unit of a database.
- ii. Field: This is a single piece of information as it consists of a group of characters. For instance, when a group of different alphabets are put together then the field person's name is formed and is referred to as the name field. Similarly, the addition of numbers in a sales amount forms a sales amount field. A field can have various attributes (i.e., a characteristic or quality), for instance, if a field contains numeric data then it has a numeric attribute. A data field represents an attribute of some entity (i.e., an object, place or an event).
- iii. Record: A record is a collection of related fields of data which are grouped together. A record represents a collection of attributes that describe an entity. A record consists of fields. For instance, a payroll record of a person may consist three data fields: Name, Social Security Number and Rate of pay. Fixed-length records contain a fixed number of fixed-length data fields while variable-length records contain a variable number of fields with variable field lengths.
- iv. **File:** A file or a table is a collection of group of related records. For instance, an employee file would contain records of the employees of a firm. The files are named, based on their application in a particular area. For instance, a file used in the area of payroll is referred to as payroll file. A file used in the field of inventory management is known as inventory file. Almost all the information stored in a computer must be in a file. The different types of files are data file, text files, program files, directory files etc. Based on the type of data stored in a file, it is named as document file or a graphical image file. It may also be possible to name the files based on the nature of the records. For instance, a transaction file may contain records that are used to carry out day-to-day or monthly transactions. A master file may contain records which have become a part of history with the passage of time.
- v. Database: It is an integrated collection of logically related records or objects. A database consolidates records previously stored in separate files into a common pool of data records that provides data for many applications. According to British computer society, a database is a collection of structured data. The structure of the data is independent of any particular application. According to Certified Institute of Management Accountants (CIMA), a database is a file of data structured in such a way that it may serve a number of applications without its structure being dictated by any one of those applications, the concept being that programs are written round the database rather than files being structured to meet the needs of particular programs.

In a database, data is organized in such a way that the computer program can easily retrieve the data for processing and produce result as per the program instructions. The data stored in the database is independent of both the application programs that use the data, and the secondary storage devices. Another concept in the database design is the Hypertext database. In Hypertext database, a picture, text or a film can be linked to another picture, text or a film. When an object (i.e., a text, film or a picture) is selected then the user can observe the related objects that are linked to it. For instance in an inventory database, a phrase, "machine breakdown" may be selected by clicking the mouse. This selection will display information regarding the number of machines that stopped working in an entire year or in a particular month and the number of working hours lost. Information from the database can be accessed by means of Database Management Systems (DBMS).

### 5.1.1 DATABASE MANAGEMENT SYSTEMS (DBMS)

A DBMS is a set of computer programs that controls and allows the creation, maintenance, storage, modification and extraction of information from a database by the end-users. DBMS consists collection of interrelated data and a set of programs to access that data. The collection of data is usually referred to as the Database which contains information about one particular enterprise. DBMS provides an environment which is both convenient and efficient in retrieving and storing database information. They are designed to manage large bodies of information. Data management involves two aspects. One is the definition of structures for the storage information, and the second is the provision of mechanisms for the manipulation of information. Database systems are designed to ensure safety of information even when the system crashes. These systems make it possible for several users to access data without giving anomalous results.

There are different types of DBMS to be used on PCs or mainframes. DBMS organizes information in relational, network, flat or hierarchical manner. The different ways of organizing information will have its influence on the flexibility and speed of extracting information. Database management packages are available for micro, midrange and mainframe computer systems.

### 5.1.2 SERVICES OFFERED BY DBMS

Following are the services offered by DBMS:

- **Data Definition:** It is possible for users to define the database with the help of Data Definition Language (DDL). With the help of DDL, users can specify the data types and structures and also the constraints on the data stored in the database.
- **Data Maintenance:** Care is taken to see that each record contains information about one particular item.
- **Data Manipulation:** The Data Manipulation Language (DML) provides the facility for the users to Insert, Update, Delete and Sort data in the database. DML also provides a general facility to put questions and get answers with the help of database. This facility is termed as query language. The most common query language is the Structured Query Language (SQL) which has become both a formal and defacto standard language for relational DBMSs.
- **Data Display:** DBMS provides the facility for the user to view data in the database. It provides a facility known as a view mechanism which allows each user to have his/her own view about the database. A view is nothing but a small subset of the database. For instance, a view may be set up which allows finance department to see the addresses of different organizations providing finance, their term period, terms and conditions for different projects and the rate of interest charged. Views help to maintain security by excluding unauthorized users from accessing the database. They also provide a mechanism to customize the appearance of the database.
- **Data Integrity:** The integrity system maintains the consistency of stored data. In addition, the security system prevents unauthorized users from accessing the database. This prevents unauthorized deletion or additions to the existing data. A user-accessible catalog is also present which contains description of the data in the database.

# 5.2 The Model Management System

The model management system is responsible for retrieval, storage and organizational activities that go along with the various quantitative models that provide analytical support for the DSS. A model helps to visualize an event and is built to study that event in detail. The model base stores and organizes the various models used by DSS during the analysis of the data. The MBMS (or Model Base Management System) is the counterpart to the DBMS. While DBMS is concerned with the data used by DSS, MBMS is concerned with the models used by DSS. The model base differentiates DSS from other information systems.

### **5.2.1 GENERAL FUNCTIONS OF THE MBMS**

Following are the general functions of the MBMS:

- Modeling language: It facilitates the creation of decision models and also
  provides a mechanism for linking multiple models that helps in sequential
  processing and data exchange. There is also a provision for the user to
  modify models so as to bring about specific preferences.
- **Model library:** As how a general library stores various kinds of books, a model library stores and manages all models, provides a catalog, an organizational schema and a description about various stored models.
- **Model manipulation:** This takes care of the management and manipulation of the model base with the help of functions such as run, store, query, etc., as how DBMS allows for querying the data stored in a database.

## 5.3 Knowledge Engine

Knowledge engine performs functions such as recognizing a problem and finding an interim or final solution in addition to other functions related to the management of the problem-solving process. A decision requires information along with reasoning. The knowledge base is a repository of information stored by the DSS. The different forms in which knowledge exists are: raw information, or rules, heuristics, constraints or previous outcomes. This knowledge is different from information which exists either in the database or model base since, it is problem-specific there.

Knowledge contained in the base can be categorized into two simple groups.

- Facts which can be considered to be true at a given time.
- Hypotheses that represent the rules or relationships believed to be existent between the facts.

### **Knowledge Acquisition and Retrieval**

It is the responsibility of knowledge engineers to collect information for the knowledge base. These people posses, special techniques (after being trained) for extracting information from the domain experts. The inference engine is the part of knowledge base that applies the rules to pull the information out in the form the user desires.

# 5.4 The User Interface

The design and implementation of the user interface is a key element in DSS functionality. An interface is a component designed to allow the user to access internal components of a system. In general, the more common the interface, the less training need be provided to users. The general functions of a DSS interface are the communication language and the presentation language.

### 5.4.1 GENERAL FUNCTIONS OF THE DSS INTERFACE

- **Communication language:** It facilitates interaction with the DSS in a variety of ways, identifies form of input, provides support to DSS users, and captures previous conversations in order to improve future interactions.
- **Presentation language:** It helps in the presentation of data in different formats, allows for detailed report generation, and can provide multiple views of the data.

### 5.5 The DSS User

The user plays an important role in the design, implementation, and effective usage of DSS. The part played by the user is no less important than hardware and software in a DSS. The user may be in the form of a decision maker, intermediary, maintainer, operator or a feeder.

Patterns of DSS User:

- Subscription mode wherein the decision-maker receives regularly scheduled reports.
- Terminal mode wherein the decision-maker interacts directly with the DSS.
- Clerk mode wherein the decision-maker uses the system directly, but not online. There is some delay in the output response.
- Intermediary mode wherein the decision-maker interacts through the use of one or more intermediaries.

# 6. FACILITATING PROBLEM-SOLVING AND AID FOR NON-STRUCTURED PROBLEMS

A decision is a choice that has to be made in order to follow a course of action. It also brings with it a strategy for going along the path of action. The end result of any decision is a certain desired objective. Decision-making is an activity of producing a new piece of knowledge that indicates a certain level of commitment to some course of action.

Right from their inception, DSSs were recognized to have the capability to support operational decision-making at any level in an organization. DSS could support financial and strategic decision-making. During the 80s emphasis was laid on the study of DSS in universities and organizations, resulting in the expansion of their scope of applications. Many new systems were developed whose functions extended beyond the support being initially provided for business and management domain. All such systems came under the purview of DSSs.

Decision Support Systems (DSSs) lend support to the decision makers in semi-structured and unstructured problems. In addition they lend support for interdependent or sequential decisions. Therefore they can be used by managers working at all levels. Since the working style of different managers is different, they support variety of decision processes and styles. They support intelligence, design, choice and implementation activities. Since decisions require building of models, they also lend support to the modeling and analysis activities. By using DSS, the effectiveness of decisions is well-balanced with efficiency. Therefore, the benefits that are derived from using flexible, interactive and adaptable DSS would not only ease the work of managers but would also provide cost advantage. Present day DSS are integrated with Internet and Web, which enhance their decision-making ability. This is because more variables can be included in decision-making.

An increase in the decision-making capability and the ability to take speedy decisions with the aid of DSS would enhance the personal efficiency of the managers. When the clarity of the decisions is increased, managers can give directions regarding their implementation in unambiguous terms. This will facilitate interpersonal communication thereby promoting learning and training. Managers can thus exercise better control over the organization through DSS.

DSSs are designed for developing a model of a problem, simulation and statistical analysis in those situations which require semi-structured decision-making. The characteristics of DSS which help in such situations are interactivity, a user-friendly environment, and graphical user interface.

## 6.1 Examples of Practical Applications of DSS

Following are the examples which illustrate the practical applications of DSS:

- i. The prominent area of application of DSS is the field of business and management. Software such as executive dashboard and other software which indicate the performance of business help in reducing the time frame for taking decisions, pinpointing the negative trends and better distribution of business resources.
- ii. Besides business, another area where DSS finds application is the field of agriculture. DSS helps in production, marketing and sustainable development. A software package with DSS orientation would allow the assessment of different agricultural production systems that are put in use in different parts of the world to facilitate decision-making at the farm and policy levels.
- iii. DSS are also used by bank officials to verify the creditworthiness of customers applying for loans.
- iv. An engineering company can use DSS to determine the worthiness of its bid in terms of competitiveness and cost.
- v. A DSS can also be used to make stock market decisions and also in segmenting the market and sell the product.

## SUMMARY

- Organizations are required to collect data, convert that data into information and process information. Based on that information they are required to make decisions and then implement them in order to achieve organizational objectives.
- DSS are interactive, computer-based information systems that use decision models and specialized databases to assist decision-making processes of managerial end users. The important users of DSS are business executives or some other group of knowledge workers. They are designed to provide end users who are usually managers with information in an interactive session as and when they require it.
- DSSs have become prominent tools for an organization, using which the organizations can enhance its decision making capabilities. Different types of decisions are: structured decision, unstructured decision and semi-structured decision.
- DSS accesses and processes large volumes of internal and external data and makes it available to various decision-making models. Internal data is collected from internal sources like Transaction Processing System (TPS) or from other information systems. External data may come from various journals, stock market publications and economic survey reports or from databases maintained by government or private agencies.
- A Group Decision Support System (GDSS) can be defined as an interactive, computer-based system that helps a team of decision-makers solve problems and make choices. A GDSS system can also be defined as an interactive, computer-based system that facilitates solution of unstructured and semi-structured problems by a set of decision-makers working together as a group.
- The components of decision support systems are data management system, model management system, knowledge engine, user interface and the users.
- For making a decision, the data management system brings to light the relevant data, stores it and also organizes it. Database is an integrated collection of logically related records or objects. A database consolidates records previously stored in separate files into a common pool of data records that provides data for many applications. A DBMS is a set of computer programs that controls and allows the creation, maintenance, storage,

modification and extraction of information from a database by the end-users. The model management system is responsible for retrieval, storage and organizational activities that go along with the various quantitative models that provide analytical support for the DSS. The knowledge engine performs functions such as recognizing a problem and finding an interim or final solution in addition to other functions related to the management of the problem-solving process. The user plays an important role in the design, implementation, and effective usage of DSS.

• Decision Support Systems (DSSs) lend support to the decision-makers in semi-structured and unstructured problems. In addition they lend support for interdependent or sequential decisions. Therefore they can be used by managers working at all levels.

# <u>Chapter VI</u> Decision Support System Architecture

# After reading this chapter, you will be conversant with:

- Basic Architecture of Decision Support System
- User System Interface
- Language System
- Presentation System
- Knowledge System
- Knowledge Management Systems (KMS)
- Problem Processing System

A Decision Support System (DSS) is an automated system and through its interactive procedures gives Decision-Maker, (DM) the ability to understand the problem by providing with all the necessary information, the capacity to search the database on the basis of requirements of the user and also to bring to light different scenarios through decision-making process. Especially, a DSS is used to consider structured or semi-structured problems. In addition, due to the existence of various kinds of decisions, and different kinds of data needing different methods of analysis, the DSS that is constructed must be flexible. The construction should be such that the user should conceptualize his decisions by means of pictures and graphs and interpret his outputs so that he can exercise control over every step of the process directly. A DSS must be user-friendly because every user has his own style and ability.

# **1. BASIC ARCHITECTURE OF DECISION SUPPORT SYSTEM**

The systematic study and research of DSS topics can benefit from a framework that identifies fundamental DSS constituents and their relationships. Ideally, the framework should not be so detailed/restrictive that it precludes consideration of some DSSs. The generic architecture of a DSS consists of three fundamental components, described by different elements, as shown in the figure 1.



Figure 1: Basic Architecture of Decision Support System

DSS is defined in terms of

- Knowledge System (KS).
- Problem Processing System (PPS).
- User System Interface (USI).

The KS and USI are systems of knowledge representation. The PPS is a software system that uses these representations in recognizing/solving problems.

We consider three important issues in relation to DSS architecture. They are:

- i. **Interoperability:** The interoperability of DSS determines the extent to which information can be delivered to the exact point at which decision can be taken. In other words, the information supplied by DSS should be effective and efficient for taking decisions. Interoperability determines to what extent DSS is capable of delivering its information to the end users at the location and time of their need. Thus, the end users and DSS must be able to integrate into a much larger enterprise information environment consisting of different information systems and platforms. The applications supported by DSS should be able to access data stores that are under the management of another application or are external to the organization.
- ii. **Compatibility:** Compatibility determines to what extent the design of DSS would help it work in harmony with other existing platforms and data stores within an organization. It is necessary for organizations to move towards those data models which avoid redundancy. It is also necessary to reduce the cost of acquiring, transmitting and using information. Hence, an overall view taking into consideration the design of all applications and data stores is required in all organization.

iii. Scalability: Scalability determines the extent to which an application or a platform can be enlarged to satisfy the increase in processing requirements due to bottlenecks throughout the system. For developing an information system that caters to an entire organization, scalability factor takes prominence because new processing requirements would be generated with the passage of time.

## 2. USER SYSTEM INTERFACE (USI)

When computer-based information systems are designed, proper attention should be given to the software that supports the user interface. USI is the term that is used to cover all aspects of system design that affect the usage of the system. It is the mechanism of interaction between the user and the system. It is made up of two parts i.e., Language System (LS), and Presentation System (PS). The interface system converts the commands, expressed in the natural language of the user into a form that can be understood by the PPS and the KS. The output must be shown clearly and not ambiguously. The arrangement of the LS with the PS depends on the type of interface. When user interface designed is not up to the mark, then users start complaining. They find it very hard to use the system or learn the basics of operating the system. The users experience with the system determines to a large extent its utility.

It is to be noted that the design of the user interface software involves not only cost but also time. The software is critical for the performance of the system in an effective manner. If the efficiency of the software is less, users have to put more effort on their part while using the system.

Software is not the only important factor that influences the performance of the user. Other factors of importance are the design of the workstation, physical display characteristics, layout of the keyboard and environmental factors like the light and noise, the design of paper forms and written documents and training material prepared for the users etc. In the design, these factors must also be taken into account.

## **3. LANGUAGE SYSTEM**

Language System (LS) is present to manage the input. When using this system, the user inserts data and chooses the model that is to be applied. LSs do not come under the category of software. It is a representational system consisting of different requests a user can make to have DSS solve a problem. The user chooses or states one of the LS elements. It can be a menu, a command, a click of the mouse, natural language, fill-in-blank, direct manipulation-oriented and question/answer or a combination of these. LS may range from being procedural to non-procedural. It is necessary for the user to have knowledge about the grammar and vocabulary part of LS.

**Command-oriented:** The range is from procedural to non-procedural. The user must learn LS vocabulary and grammar.

**Natural Language:** System adjusts its LS to user's presentations. However, there will be a problem of misinterpretation.

**Menus:** It gives guidance to users about possible requests. The user reacts to presented options. LS consists of keystroke sequences (mouse manipulations, etc.) that facilitates various requests from the users.

**Forms:** With forms, LS guides the user in filling the slots in the forms. There is a possibility to edit any items entered prior to completion. LS comprises possible entries for forms.

**Question/Answer:** This is simple case of a form. LS provides a sequence of keystrokes that could mean an answer to a question.

**Direct Manipulation:** It means that requests can be made by manipulating system presentations of objects. LS assists users in manipulating Presentation System (PS) elements. Examples include forms interfaces, graphical user interfaces are Speech and Hybrids.

Other forms include speech or a combination of the above given forms.

## 4. PRESENTATION SYSTEM

Presentation System (PS) performs the function of managing the output produced by DSS. The output is presented in the form of schedules, graphs, thematic tables, etc. Like LS, PS is also not a piece of software. It is a representational system comprising all responses that are given out by DSS. The Problem Processing System (PPS) determines which PS element that is to be used for a response.

With respect to the PS, assistance messages can follow the foregoing styles. Resulting messages can be classified as textual (free-form and structured), graphical, audio and combinations. Textual messages include freeform, tabular, grid, form, graphical messages include plots, drawings, images. It is necessary that developers be familiar with all of these possibilities and pay close attention to the tools that accept LS requests and present PS responses.

## 5. KNOWLEDGE SYSTEM

Knowledge System (KS) is not a piece of software. It is a representational system containing all readily changeable knowledge available to the DSS for use in problem solving and communicating. No type of knowledge is precluded. In principle, any knowledge representation technique is permissible. KS contains the whole information about the problem. It is made up of three parts:

- i. Database (DB).
- ii. Model Base (MB).
- iii. Rule Base (RB).

# 5.1 Database (DB)

A database is an integrated collection of logically-related records or objects organized and stored in a manner that facilitates its easy retrieval i.e., it contains the record of quantitative and structured data. It is very important because the quality and structure of the DSS data base component largely determines the success of modern DSS. A database consolidates records previously stored in separate files into a common pool of data records that provides data for many applications. According to British computer society, A database is a collection of structured data. The structure of the data is independent of any particular application. According to Certified Institute of Management Accountants (CIMA), a database is a file of data structure being dictated by any one of those applications, the concept being that programs are written round the database rather than files being structured to meet the needs of particular programs.

In a database, data is organized in such a way that the computer program can easily retrieve the data for processing and produce result as per the program instructions. The data stored in the database is independent of both the application programs that use the data and the secondary storage devices. Another concept in the database design is the Hypertext database. In Hypertext database, a picture, text or a film can be linked to another picture, text or a film. When an object (i.e., a text, film or a picture) is selected, then the user can observe the related objects that are linked to it. For instance in an inventory database, a phrase, "machine breakdown" may be selected by clicking the mouse. This selection will display information regarding the number of machines that stopped working in an entire year or in a particular month and the number of working hours lost. Information from the database can be accessed by means of Database Management Systems (DBMS). The different categories of databases that are found in computerized environments or organizations are:

- **Operational Databases:** As the name suggests, these databases are helpful in carrying out the operations of the organization. They are also known as Subject Area Databases (SADB), transaction databases and production databases. Examples include customer database, personnel database, inventory database and other databases which come into existence due to business operations.
- Analytical Databases: These databases contain data and information extracted from selected operational and external databases. These databases are intended to provide summarized data and information for managers of an organization and end-users. They are also known as management databases or information databases. These databases use multidimensional database structures to organize data and hence they are also known as multidimensional databases. Information systems like OLAP, DSS and EIS access data from these databases.
- Data Warehouse: The term Data warehouse was first coined by W.H Inmon. Data warehouse is defined "as subject-oriented, time variant, integrated and non-volatile collection of data in support of decision-making process." A data warehouse is a central repository for all or significant parts of the data that are collected by various business systems of an enterprise. It is a repository of historical and current data related to the business process of a company which is stored in an organized format. This central source of data is screened, edited, standarized and integrated so that it can be used by managers and other professionals for business analysis, market research or decision-making. Data warehouse is stored on the mainframe server of an enterprise. It may be subdivided into data marts which hold subsets of data from the warehouse. Data which is generated through Online Transaction Processing (OLTP) applications, non-transaction applications and other sources is extracted on a selective basis and it is structured and organized on a data warehouse database to satisfy user queries. The data stored in a data warehouse is very useful for management when it is converted into business information. Another useful application of data warehouse database is data mining. In data mining, data from the data warehouse database is processed to find out or identify any underlying pattern of business activity.
- End-user Databases: These databases are a collection of data files developed by end-users at their workstations. For instance, users may download files from different sources with the help of Internet and WWW, or may have text, graphic, video or audio files sent by other users through E-mail. All this data is stored in these databases.
- External Databases: Organizations or users may obtain a large amount of information from databases that are outside the purview of their sphere of influence. This information may be available free or a fee may have to be paid for it. Websites provide access to hyperlinked pages of multimedia documents in hypermedia databases. The data may relate to for instance different fields like statistics, demography, politics, art, science, culture, etc. In addition, there are hundreds of newspapers, magazines, research journals/articles, full text databases, etc., which may be of interest to a group or organization for different purposes.

## 5.2 Model Base (MB)

The model base in a DSS is the modeling counterpart to the database. Just as the DSS database stores the data used by the DSS, the model base contains the various statistical, financial, forecasting, management science, mathematical and other quantitative models that provide the analysis capabilities and thus help in

performing analysis in a DSS. It is the model base that differentiates a DSS from other Computer-Based Information Systems. The ability to run, invoke, combine, change and inspect models is an important DSS capability that differentiates it from other Computer-Based Information Systems (CBIS). A model base consists of four different categories of models. They are: strategic, tactical, operational, and analytical.

We shall discuss each of these models in detail:

- i. **Strategic Models:** These models are used by the top managerial personnel to execute their strategic planning responsibilities. Examples where strategic models are applied include e-commerce venture, developing corporate objectives, planning for mergers and acquisitions, selecting a location for a plant, analyzing the impact of environment and capital budgeting decisions which are not or routine type. Linear programming models help executives in analyzing expensive and large scale projects. Each organization develops its own model of strategic planning. There is no universal planning model that is perfect in all respects. A model is selected by an organization and it is modified based on its own planning process. An organization can also integrate models to uniquely identify strategic issues and goals. For instance, members of the design team develop a number of process models and all these models are synthesized to develop a process model of a new university run by any corporate organization.
- ii. **Tactical Models:** These models are used by managerial personnel from middle-level. These models are helpful in allocating and controlling the resources of an organization. Examples of tactical models are, selection of a Web server, planning for a sales promotion, planning for labor requirement, determining the layout of a plant and capital budgeting of routine nature. The middle-level managerial personnel who are responsible for using the tactical models are responsible only for a particular department of the organization such as accounting department. Tactical models require to a large extent the internal data and very little external data. Tactical models can be used for developing cost estimates and capacity measurements.
- iii. **Operational Models:** These models are used for carrying out everyday activities of an organization. Such activities include acceptance of E-commerce transactions, giving sanction to home loans by a bank, determine the production schedule, controlling the inventory, and quality control. These models are used by first-line managers for making decisions whose time frame is one day to one month.
- iv. Analytical Models: These models help in analyzing data. Examples of such models are statistical models, management science models, financial models and algorithms for data mining. The integration of these models with strategic planning models would help in converting data into information that can be used by managers to take decisions. The study of analytical models comes under business analytics. The tools of business analytics are Web-based and hence the term Web analytics has become popular. The tools of Web analytics can be applied to Web systems. Business analytics software is easy to use. Examples of which are Online Analytical Processing (OLAP).

The models in model base can also be differentiated based on the functional areas such as financial models, marketing models, production control models etc. The ability to run individual or combined models or to construct new models makes the DSS a powerful support tool in the problem-solving environment.

### 5.3 Rule Base (RB)

It contains the rules and logical relations for qualitative inference. In this, probabilistic relations are used to represent fuzzy concepts. Rule-based reasoning approach is used mostly by Artificial Intelligence (AI). In this approach, computer is given the characteristics of the problem space in the form of input values. It then

### Decision Support System Architecture

uses the rules contained within its knowledge base to methodically change the static of the problem space to the desired condition. Each rule is composed of two parts: (i) the operator that performs the state change, and (ii) the conditions that determine when an operator may be executed. Generally, it is expressed as an IF-THEN statement which we commonly find in a number of high-level computer programming languages. The syntax of the statement is:

IF condition THEN operator.

If the condition is found to be logically true, then the operator is considered to be an acceptable action to be taken and the rule is said to have been executed. If the condition is found to be logically false, then the operator is ignored and no action is taken based on the operator. The control then goes to the next rule. This process continues until the problem space reaches the desired condition or the rules in the knowledge-base are over.

Based on the set of rules, different types of knowledge can be encoded. We shall discuss each of them with the help of examples.

i. **Inferential knowledge:** Here, a conclusion is reached as a result of one or more premises (facts) being established. It takes the form:

IF	premise(s)

THEN conclusion

Example:

**IF** red light signal

THEN do not cross the road using a vehicle

ii. **Procedural knowledge:** Here, the condition takes the form of a stated situation and the operator becomes an action to take when the stated situation is logically true.

IF	situation
**	Dittaution

THEN action

Example:

**IF** price on the ticket = Rs.100

THEN allow the ticket holder in the balcony

- iii. **Declarative knowledge:** This form is constructed from antecedents and consequents. If antecedent (condition portion of the rule) is found to be logically true, then the consequent (operator) must also be true.
  - IF antecedent
  - THEN consequent

Example:

- **IF** found guilty of drunken-driving
- THEN driver must be jailed

# 6. KNOWLEDGE MANAGEMENT SYSTEMS (KMS)

Knowledge Management Systems (KMS) are communications systems designed to facilitate the sharing of knowledge rather than just information. They support the creation, capture, storage, and dissemination of firm's expertise and knowledge. They support processes for discovering and codifying knowledge, sharing knowledge, and distributing knowledge, as well as processes for creating new knowledge and integrating it into the organization. They are information systems that facilitate organizational learning and knowledge creation.

A knowledge repository is a collection of documented internal and external knowledge in a single location for more efficient management and utilization by the organization. Knowledge collected from different sources can be documented using tools provided by web-based systems and traditional

document management systems. Knowledge repositories may have tools to access information from the corporate databases. The knowledge base of an organization may include:

- i. **Structured Internal Knowledge (Explicit Knowledge):** It is in the form of product manuals or research reports. It is codified in the databases of corporate procedures and best practices. The computer applications and resources like Internets, intranets, electronic mail, databases and search engines are based on this type of knowledge.
- ii. **External Knowledge:** It is the knowledge of competitors, external products, markets and business intelligence. It can be gathered from a variety of sources like trade journals, magazines, annual reports, government publications and analysis of expert opinion.
- iii. **Tacit Knowledge:** It is also known as informal internal knowledge. It resides in the minds of business executives. It is an asset gained by them through years of experience, social interaction, sharing and practice. It is not documented and has no fixed pattern.

It has become essential for companies to build Knowledge Management Systems (KMS) to manage organizational learning and business know-how. KMS helps knowledge workers to create, organize and make available important business knowledge in the critical areas of business at the right time and place. Knowledge workers are people such as engineers, scientists or architects who design products or services or create knowledge for the organization. They perform three main roles which are critical for the success of the organization. They are:

- They provide the organization with all the latest and updated knowledge and technical know-how in the field of science, technology, art and social thought.
- They act as internal consultants by guiding the organization in the discovery of opportunities, implementation of changes and marking the areas which require the application of technical and business knowledge.
- They also act as change agents by evaluating, initiating and promoting change projects.

Technical and business knowledge is the corner stone for the success of any enterprise. KMS can provide rapid feedback to knowledge workers, encourages them to bring about progressive changes in the business processes and improve business performance. KMS is important for the organization because as the organization grows in size, its scale of operation increases and as it ventures into different areas of business, its knowledge base grows. The management of knowledge and its application in the development of new products and services ensures customer satisfaction and increased market share.

Knowledge management applications also involve mapping sources of knowledge, creation of corporate knowledge directories of employees with special areas of expertise, identifying and sharing best practices and codifying the knowledge of experts so that it can be embedded in information systems and used by other members of the organization. KMS tools enable knowledge discovery by helping organizations to find out important relationships among the vast pool of data.

## 6.1 Knowledge Work Systems (KWS)

KWS are the information systems that aid knowledge workers in the creation and integration of new knowledge in the organization. KWS must provide knowledge workers with specialized tools such as powerful graphics, analytical tools and communications and document management tools. These systems should also provide accurate, fast and large computing power in order to handle complex calculations and sophisticated graphics. This is because researchers, designers and financial analysts have to process and develop three dimensional graphical models based on the large amount of data at their disposal. These systems must give easy access to external databases since knowledge workers have to gather data and discover patterns from external world. A user-friendly interface with knowledge work systems helps knowledge workers to carry out their tasks quickly and efficiently and access required information in the shortest possible time. All these facilities can be provided with the help of specialized hardware and software.

**Examples of KWS:** The examples of KWS are Computer-Aided Design (CAD) systems, Virtual reality systems for simulation and modeling, and financial workstations. A CAD system automates the creation and revision of designs, using computers and sophisticated graphics software. Virtual reality systems have visualization, rendering and simulation capabilities which are much more sophisticated than the CAD systems. The knowledge of brokers, traders and portfolio managers can be pooled together and utilized with the help of specialized investment workstations. Sophisticated PCs are used in the financial sector to analyze trading situations instantaneously and facilitate portfolio management.

# 7. PROBLEM PROCESSING SYSTEM

Problem Processing System (PPS) is the DSS software that reacts to user requests and brings out a corresponding response to the problem. It takes an element of the LS and draws on elements of the KS to produce an element of the PS for the user and/or to modify KS contents. It is necessary that PPS must be able to process each knowledge representation held in the KS, act on each element allowed in the LS, and present each PS element. The framework is independent of LS contents, PS contents, KS contents, and PPS dynamics. A system must be represented in such a manner that PPS can comprehend and process it. Likewise the PPS must be able to express output in a manner that can be understood by the user or another DSS. Additionally, knowledge in the KS must be represented in a manner that the PPS can understand. Representation systems are not software, but may contain software as part of the system. A system of processing is software that reacts to user's user requests and drives the problem solving process toward a corresponding response. It draws on LS, PS and the KS to execute its purpose.

PPS is a software which generates useful answers for the decisional process and handles the information of the KS. It is made up of three parts:

- i. Data Base Management System (DBMS).
- ii. Model Base Management System (MBMS).
- iii. Inferential Machine (MOT.INF).
- i. Data Base Management System (DBMS): A DBMS is a set of computer programs that controls and allows the creation, maintenance, storage, modification and extraction of information from a database by the end-users. DBMS consists of collection of interrelated data and a set of programs to access that data. The collection of data is usually referred to as the Database which contains information about one particular enterprise. DBMS provides an environment which is both convenient and efficient in retrieving and storing database information. They are designed to manage large bodies of information. Data management involves two aspects. One is the definition of structures for the storage information and the second is the provision of mechanisms for the manipulation of information. Database systems are designed to provide safety of information even in times when system crashes. These systems make it possible for several users to access data without giving anomalous results.

There are different types of DBMS to be used on PCs or mainframes. DBMS organizes information in relational, network, flat or hierarchical manner. The different ways of organizing information will have its influence on the flexibility and speed of extracting information. Database management packages are available for micro, midrange and mainframe computer systems.

Following are the services offered by DBMS:

- **Data Definition:** It is possible for users to define the database with the help of Data Definition Language (DDL). With the help of DDL, users can specify the data types and structures and also the constraints on the data stored in the database.
- **Data Maintenance:** Care is taken to see that each record contains information about one particular item.
- **Data Manipulation:** The Data Manipulation Language (DML) provides the facility for the users to Insert, Update, Delete and Sort data in the database. DML also provides a general facility to put questions and get answers with the help of database. This facility is termed query language. The most common query language is the Structured Query Language (SQL) which has become both a formal and defacto-standard language for relational DBMS.
- **Data Display:** DBMS provides the facility for the user to view data in the database. It provides a facility known as a view mechanism which allows each user to have his/her own view about the database. A view is nothing but a small subset of the database. For instance, a view may be set up which allows finance department to see the addresses of different organizations providing finance, their term period, terms and conditions for different projects and the rate of interest charged by them. Views help to maintain security by excluding unauthorized users from accessing the database. They also provide a mechanism to customize the appearance of the database.
- **Data Integrity:** The integrity system maintains the consistency of stored data. In addition, the security system prevents unauthorized users from accessing the database. This prevents unauthorized deletion or additions to the existing data. A user-accessible catalog is also present which contains description of the data in the database.
- ii. **Model Base Management System (MBMS):** Models are used by decision-makers to convert data into useful information. A model is an object or a concept that can be used to represent a practical situation such as a physical machine or a system. The scale in which a model is presented is very small or can be called an abstract form. But, all the features of the real situation are represented in the model. A model may be in the form of a mathematical expression, in the form of natural language statements or in the form of a computer program. A mathematical model is the one where the representation is in the form of a mathematical concept involving constants, variables, functional relationship and constraints. A model base is a collection of different types of models that are contained in an electronic storage medium and accessible to users and programs.

MBMS is a software package that facilitates the management of model base in a convenient manner, analogous to database management. It helps in the creation of models in an easy manner either from the beginning or by modification or updation of the existing models. It can also generate and update the required parameters. Users can manipulate the models for conducting experiments. They can also perform sensitivity analysis. This software package is useful to store and manage different types of models in a logical and integrated manner. It also has a catalog and a directory that displays different models that can be used by various individuals in an organization. It also keeps a record of the type of the models used and data and applications accessed. It can also link up the models for usage in an integrated manner.

### iii. Inferential Machine (MOT.INF)

- It contains artificial intelligence functions to manage the Knowledge System (KS).
- Use of rules and assertions to infer new facts through heuristic.
- Use of meta-rules (rules about rules), to decide what to do when more then one rule can be applied.
- Clear and logic explanation of the relationship between inputs and outputs that is often difficult to understand because of the complex information used.

# SUMMARY

- A Decision Support System (DSS) is an automated system and through its interactive procedures gives Decision-Maker (DM) the ability to understand the problem by providing with all the necessary information, the capacity to search the database on the basis of the requirements of the user and also to bring to light different scenarios through decision-making process.
- The generic architecture of a DSS consists of three fundamental components those are Knowledge System (KS), Problem Processing System (PPS) and User System Interface (USI). The KS and USI are systems of knowledge representation. The PPS is a software system that uses these representations in recognizing/solving problems.
- Language System (LS) is present to manage the input. When using this system, the user inserts data and chooses the model that is to be applied.
- LS elements can be a menu, a command, a click of the mouse, natural language, fill-in-blank, direct manipulation-oriented and question/answer or a combination of these.
- Presentation System (PS) performs the function of managing the output produced by DSS. The output is presented in the form of schedules, graphs, thematic tables, etc.
- Knowledge system is a representational system containing all readily changeable knowledge available to the DSS for use in problem solving and communicating. KS is made of three parts: database, model base and rule base. A database is an integrated collection of logically-related records or objects organized and stored in a manner that facilitates its easy retrieval. The model base in a DSS is the modeling counterpart to the database. The Rule Base contains the rules and logical relations for qualitative inference.
- Knowledge Management Systems (KMS) are communications systems designed to facilitate the sharing of knowledge rather than just information. They support the creation, capture, storage and dissemination of firm's expertise and knowledge.
- Problem Processing System (PPS) is the DSS software that reacts to user's requests and brings out a corresponding response to the problem. It takes an element of the LS and draws on elements of the KS to produce an element of the PS for the user and/or to modify KS contents.
- MBMS is a software package that facilitates the management of model base in a convenient manner, analogous to database management. It helps in the creation of models in an easy manner either from the beginning or by modification or updation of the existing models.
- User System Interface covers all aspects of system design that affect the usage of the system. It is the mechanism of interaction between the user and the system. It is made up of two parts i.e., Language System (LS), and Presentation System (PS).

# <u>Chapter VII</u> Building Decision Support Systems

# After reading this chapter, you will be conversant with:

- Phases of DSS Development Process
- System Development Life Cycle
- ROMC Analysis
- Prototyping
- Functional Category Analysis
- Incremental Design
- Skill Set of DSS Developer

The design of Decision Support System (DSS) in the present times has become very complex due to the introduction of Business Intelligence (BI) applications and the technologies such as Online Analytical Processing (OLAP), Data Mining and Data Warehouse. These applications and technologies enhance the capabilities of DSS. To manage these applications and technologies, proper methodology must be incorporated in the development process so as to make use of different tools and platforms. In this way, the requirements of the manager would be satisfied.

Decision Support Systems (DSSs) may be developed by a single person, a large group or a small team. Based on the applications supported by the DSS, the size of the team building it differs. For instance, a large and complex DSS requires the team effort of large number of people, whereas a small DSS can be built by an individual. A team can build a DSS by using the System Development Life Cycle (SDLC) because it requires a large amount of planning and effort. In this chapter, we shall consider various design paradigms of DSS development and also the skill set required by a DSS developer.

## 1. PHASES OF DSS DEVELOPMENT PROCESS

DSS development process consists of the following activities:

- i. **Planning:** It should be known before hand the purpose of installing DSS in an organization. The DSS should be based upon the needs that it is going to satisfy and the problems for which it is going to offer solutions.
- ii. **Research:** There are many approaches to the design and development of DSS. Many technologies are available for the development of DSS. A number of features can be included in the DSS. The designers of a DSS system should conduct preliminary research to shortlist the approach that would produce DSS in the shortest possible time and with minimum cost. There are many different strategies for the development of DSS. They are: writing a customized DSS in any general purpose programming language such as COBOL, C++, Java etc., making use of a Fourth-Generation Language (4 GL), making use of a DSS integrated development tool such as a generator or engine like Excel, making use of a domain-specific DSS generator, developing the DSS using the CASE methodology or developing a complex DSS by putting together many approaches.
- iii. System Analysis and Conceptual Design: After the approach is finalized, there is a need to find out the best practical approach for construction and making a list of the particular resources needed for implementing it. The feasibility study of the proposed system is undertaken after the conceptual design is completed.
- iv. **Design:** Design gives detailed specifications of the structure of the system, its components and also the features. The design also specifies appropriate software to be used.
- v. **Construction:** The actual physical assembling of the components according to the technical specifications is undertaken in this stage.
- vi. **Implementation:** This stage consists of testing, evaluation and demonstration of the system. The end users are oriented and trained in the details on how to handle and use the system for its final deployment.
- vii. **Maintenance and Documentation:** Maintenance involves the periodic inspection of the system and its upgradation. The method of using various components, inputs and also the outputs of the system are documented for statistics and future use.
- viii. **Adaptation:** All the previously mentioned steps are performed on a regular basis in order to respond to the changing needs of the users.

## 2. SYSTEM DEVELOPMENT LIFE CYCLE

System Development Life Cycle (SDLC) is the sequence of activities that need to be performed in the development of an information system or an application. These activities require mutual effort on the part of the user and technical staff. The systems approach to develop information system solutions involves a multistep process called the information systems development cycle, also known as the Systems Development Life Cycle (SDLC). All the activities in SDLC are interrelated and interdependent.

- i. **Recognition of Need:** One must know what the problem is before it can be solved. The basis for a candidate system is recognition of a need for improving an information system or a procedure. The identification of the problem is very important. For example, a supervisor may want to investigate the system flow in purchasing, or a bank president has been getting complaints about the long lines in the drive-in. This need leads to preliminary survey or an initial investigation to determine whether an alternative system can solve the problem. The result of this stage is the statement of scope and objectives and performance criteria.
- ii. **Feasibility Study:** A feasibility study can be defined as a preliminary study that investigates the information needs of prospective users and determines the resource requirements, costs, benefits, and overall feasibility of a proposed project. It entails the collection of data from various sources. The result of the feasibility study is a formal proposal. The proposal summarizes what is known and what is going to be done. It consists of Statement of the problem, Summary of findings and recommendations, Details of findings, recommendations and conclusions. The output of this stage is the technical/behavioral feasibility report, cost/benefit report, system scope and objective report.
- iii. Systems Analysis: It is the detailed study of various operations performed by a system and their relationships within and outside of the system. One aspect of this analysis is defining the boundaries of the system and determining whether, or not a candidate system should consider other related systems. Systems analysis thus, involves a study of the information needs of the organization and end users, the activities, resources, and products of any present information system and the information system capabilities required to meet the information needs of end users. The output of this stage is the logical model of system such as data dictionary and data flow diagrams.
- iv. **Systems Design:** Systems analysis describes what a system should do to meet the information needs of users, while system design specifies how the system will accomplish this objective. Systems design consists of activities that produce specifications that satisfy the functional requirements of an information system developed in the systems analysis stage. Systems design begins by elaborating the statement of requirements in terms of more detailed objectives. Such objectives can be specified in terms of improvements to the organization's processes and functions and what is to be done to realize the improvements. The output of this stage is the design of alternative solutions, cost estimates, hardware specifications, program test plans, formal system tests and security, audit and operating procedures.
- v. **Implementation:** Once a new information system is designed and developed, it must be implemented. This stage involves hardware and software acquisition, software development, testing of programs and procedures, development of documentation, and a variety of installation activities. It also involves the education and training of end users and specialists who will operate the new system and the conversion of a present system to an improved system. During conversion both new and old systems could either be operated simultaneously for a trial period, or a pilot system be operated at one location. The output of this stage is the training program and user-friendly documentation.

vi. **Post-implementation and Maintenance:** This is the final stage of the system development cycle. It involves monitoring, evaluation, and modification of a system to make desirable or necessary improvements. A post-implementation review needs to be done to ensure that the newly implemented system is meeting the functional business requirements that were established in the initial stage. Any defects in the analysis, design, development or implementation stage of a system needs to be corrected through regular maintenance. Systems maintenance also involves modification of a system due to internal changes within a business, or external changes in the business environment. The output of this stage is user requirements that are met successfully, confirming to user standards.

# 2.1 Advantages of SDLC

Following are the advantages of SDLC:

- SDLC has been used widely and commonly.
- It serves as a foundation for systems development which can be later modified in accordance with specific requirements.
- It lays stress on documentation, standards, quality control and project control.
- SDLC is suitable for constructing transaction processing systems and MIS which require highly structured and defined methodology.
- SDLC can be used for constructing complex systems where there is a requirement of rigor and formal requirements analysis and where formal specifications are known and there is a tight control over the development process.

# 2.2 Disadvantages of the SDLC

Following are the limitations of SDLC:

- SDLC requires large amount of resources. A large amount of time is spent in collecting information and preparing detailed documents and requirements. It is likely, that with this approach it would take many years to build a system. There is also a possibility that by the time a system is ready, the requirements initially thought might change.
- Since SDLC involves a very structured and step-wise approach to the development of DSS, this may not always work well because the needs of the users cannot be defined in clear terms at once.
- SDLC is not flexible and it is not possible to change it in a dynamic environment. SDLC was basically developed for traditional transaction processing systems. It is mostly output-driven. There is an element of cost and time involved in undertaking repetitive activities. The top-down and step-by-step approach to SDLC is a hindrance to iteration and formulation of new ideas and understanding.
- The projects may fail because there will be difficulty in estimating the costs
  of each project and each project is unique. Therefore, previous experience of
  the project may not be applicable to the new project.
- In SDLC, objectives may reflect a scope that is too broad or too narrow so that the problem the system was designed to solve may still exist or the opportunity that it was to capitalize upon may not be properly utilized.
- Since the business environment is dynamic, time may not be sufficient to complete each step of SDLC.
- SDLC may not be applicable in all situations.
- SDLC requires a lot of planning and it is difficult to implement it quickly.

### 2.3 Differences between DSS and SDLC

- DSS deal with semi-structured or unstructured problems, whereas SDLC is more suited for structured problems.
- SDLC approach is associated with the gathering of knowledge by the analysts, the process assumes that such knowledge is readily available and categorized according to a set of system requirements. But, this is untenable within DSS design and construction.
- SDLC is evolved out of developers' experience with computer-based information systems. The sequential and structured nature of the process is one of its primary strengths.
- In practice, a more iterative, bottom-up design approach might work better in SDLC.
- For DSS development—as opposed to general IS development—problems tend to be less structured and a more evolutionary design approach is needed.

# **3. ROMC ANALYSIS**

ROMC analysis is an alternative to SDLC approach. ROMC stands for Representations (R), Operations (O), Memory Aids (M) and Controls (C).

Based on this approach in the design of DSS, the analyst characterizes the various representations available for use as methods of communication between the DSS user and the DSS application. The representations may be in the form of graphical displays, charts, tables, lists, stock reports, menus, input forms and such others.

In the operations analysis, the analyst determines those activities that are necessary for the production and delivery of different types of representations that come with the system. In addition, the activities also include the interpretation, production and packaging of relevant knowledge that comes with the DSS package.

Memory aids lend support to the user who uses various representations and operations. Memory aids are in the form of databases, work spaces or blackboard systems and embedded triggers that give indications to the user when the need arises to perform specific operations that are necessary to perform the tasks currently at hand.

Control mechanism is used in the DSS to bring out or synthesize a unique decision-making process from those available in the form of representations, operations and memory aids. Controls are in the form of mechanisms such as the help that the user receives for submitting specific requests or queries to the DSS, functions that help in formatting the DSS based on the problem-solving style or tendencies of the user and modules that help the user learn the usage of particular elements within the DSS based on example rather than trail-and-error discovery.

# 4. PROTOTYPING

It is generally observed that customers, who need an application, only define a set of general objectives but are not sure about the detailed input, processing or output requirements. In another instance, the software developers are unsure about the efficiency of the algorithm, the compatibility of an operating system to the execution of the programs or the form of interaction that should take place between the computer system and the end users. In such situations and varied other types, a prototyping paradigm may be the best approach to start the software development process. Prototyping is also known as Iterative process or simply Prototyping. It is also found that use of prototyping paradigm in the design and construction of a DSS would be very efficient.

The Prototyping paradigm is shown in figure 1. This paradigm starts with collecting information or requirements from the customers. Developers and customers interact to define the overall objectives for the software, identify the requirements that the software should satisfy and earmark those areas where further definition is
mandatory. Based on these, a "quick design" is made. The quick design brings to light those features of software that will be visible to the customer or user. These features may be the input specifications and output formats. This quick design leads to the construction of a prototype.



The prototype is evaluated by the customer or the user and further changes are incorporated in it to refine it for the software to be developed. Major changes and iterations occur as the prototype is designed to satisfy the needs of the customer. The prototype can serve as "the first system". Prototype enables the users to visualize what the actual system would be when it is completely re-built. Developers would get a feeling that they have actually built something at the earliest. We can summarize the prototyping approach in the following steps:

- i. Selection of important sub-problems to be built initially. These sub-problems must be small, well defined, interesting to the user and need the support of the computer.
- ii. Development of small but usable system for the user or the customer so that by inspecting it he can suggest changes and modifications.
- iii. Constant evaluation of the system in consultation with the user or the customer. While the user is responsible for use and evaluation activities, the builder is responsible for constructing and implementing activities.
- iv. Refinement, expansion and modification of the system in cycles. The prototypes are used only for demonstrating the principles and then thrown away or they are extended, refined and developed into a working system and integrated into the formal information systems.

Thus, we find that in the development of DSS using prototyping, the early stages are similar to the classical SDLC methodology. The differences start after the development of initial prototypes. After the development of initial prototype, a repetitive and incremental process starts. In this method of development of DSS, there is an increasing interaction between the analyst and the user as more refined prototypes are developed. Compared to the role of a user who is passive or reactive in the SDLC approach, the user in prototyping approach used in the construction of DSS is an integral and active participant in the evaluation activity. The advantage of prototyping approach is that it requires a very short development time and the reaction time of the user is also very short. Since the developer and the user/customer are in constant consultation with one another, there is an improved understanding of the needs of the user from the system and the capabilities expected from the system. The cost of building DSS using the prototyping approach is very low.

There are two types of prototypes. They are:

i. Throwaway Prototype: This prototype is only for demonstrating the working model. Afterwards it is not used. After consultations with the customer and collection of requirements, a simple working model of the system is constructed to demonstrate a physical picture of the system and the requirements that it satisfies. The method of constructing the model is quite informal and it is constructed in a very short time. The users can reexamine their requirements from the system by examining the model. When the clarity in the requirements and expectations is known completely, the developed model is thrown away and a formal system is developed based on the recorded parameters. The advantage of using thrown away prototype is that there is no need to spend large amount of time as in system development life cycle method and hence the cost of development is also lower.

ii. **Iterative Prototype:** We saw in the throwaway prototype that a model that is developed is thrown away and not further used. However, in the iterative prototype method, the model is not discarded but it is further developed by incorporating other desired features in it. The refinement to the original model is continued till the final system is developed that satisfies all the requirements. It is redeveloped and continually refined until it completely satisfies the requirements and needs of the DSS users, and then any necessary integration with other existing organizational systems is performed.

# 4.1 Disadvantages

There are certain problems associated with this paradigm which are discussed below:

- i. In this approach, the customer only gets to know about the working version of the software without any consideration involved for software quality or long-term maintainability. The software development team has to make wide changes to the existing prototype while the customer thinks that there are only a few additions that are to be made or a few modifications that are to be carried out.
- ii. Since a prototype is built in the shortest possible time, the developer often compromises with the implementation. The operating system or the programming language that is used may be inappropriate but is used simply because it is available and known. The algorithm developed for the project may also be inefficient. However, the developer may be accustomed to using it.
- iii. SDLC approach involves detailed analysis of cost, benefits and information needs of the system. Here, since the development time is very less compared to SDLC there is no cautious approach towards development.

To successfully use prototype paradigm, the customer and the developer must clearly define their objectives and resources respectively in the beginning and both must agree that a prototype is built to serve as a mechanism for defining requirements. After the prototype is ready, some modifications are carried out in it and the actual software is engineered taking into account the quality and maintainability factors.

# 5. FUNCTIONAL CATEGORY ANALYSIS

Another methodology for the design of a DSS is Functional category analysis. In this, the developer identifies the specific functions necessary for a specific DSS from a broad list of available functions. It organizes the key functions of the proposed DSS into a useful arrangement, thus allowing the DSS designer to perform a more focused and detailed analysis.

#### **Functional Categories**

- Selection locating knowledge within the knowledge base for use as input to the new knowledge derivation process.
- Aggregation creation or derivation of summary statistics, such as averages or totals.
- **Estimation** creation of model parameter estimates.

- Simulation creation of knowledge about expected outcomes or consequences of specific actions within the organizational environment.
- **Equalization** creation of knowledge regarding conditions necessary to maintain consistency within the problem consistency.
- **Optimization** discovering what set of parameter values best meet a set of performance measures within a set of defined constraints.

# **6. INCREMENTAL DESIGN**

Incrementality defines a process which moves along in a step-wise fashion, in increments. The desired goal is achieved by moving closer towards it in successive approximation. Each approximation is an increment over the previous one. Incrementality principle means that the desired application is produced as a result of an evolutionary process. One approach of applying incrementality principle consists of developing initial subsets of an application and delivering them to the customers. This will help in obtaining early feedback which will allow the evolution of application in a controlled manner by incorporating many changes if initial requirements are either not stable or fully understandable.

Using incrementality, functions may be added progressively to the application being developed, starting from a kernel of functions that would still make the system useful, although incomplete. For instance, in some business automation systems, some functions are performed manually while others are done automatically by the application. In addition, successive versions of an application are released with improved performance. For instance, user interface and reliability are emphasized in earlier versions while later versions enhance the performance by improving space and time efficiency. When an application is developed incrementally, intermediate stages may constitute prototypes of the end product; i.e., they are only an approximation.

The incremental approach to development of DSS facilitates reducing rework in the development process and giving customers some opportunities to delay decisions on their detailed requirements until they gain some experience with the system. In this model, customers identify, and outline, the services that the system needs to provide. They grade the services according to their importance. A number of delivery increments are then defined, with each increment providing a subset of the system functionality. The allocation of services to increments is based on the priority of the service. Thus, services with the highest priority are delivered first to the customers.

Upon identification of system increments, the requirements for the services to be delivered in the first increment are defined in detail and that increment is developed using the most appropriate development process. During that development, requirement changes for the current increment are not entertained although further requirements analysis for, later increments can take place.

Customers put an increment into service after it is completed and delivered to them. Thus, they can receive early delivery of part of the system's functionality. They can put that part of the received system to use which will help them to clarify their requirements for later increments and versions of the current increment. The new increments that are delivered subsequently are integrated with the existing increments so that the functionality of the system is improved in successive stages of system increment. In this model, there is no need to use the same process for the development of each increment. For instance, waterfall model of development may be used for an increment where the services are well-defined and an evolutionary development model may be used where the specifications for an increment are not clear.

**Figure 2: Incremental Model** Increment 1 Increment 2 Increment 3 Analysis Analysis Analysis Design Design Desian Code Code Code Test Test Test Delivery of Delivery of Delivery of 1st increment 2nd increment 3rd increment Time Period

Figure 2 shows the block diagram of incremental model.

Following are the advantages of Incremental development process:

- i. There is no need for the customers to wait till the completion of the project. They can start using the critical increments that are initially delivered to them.
- ii. Customers can use the early increments as a form of prototype and gain experience which informs the requirements for later system increments.
- iii. In this model, there is a lower risk of total project failure. This is because part of the project is delivered to them at regular intervals as increments. It is likely, that some increments will be to the satisfaction of the customers while the others can be suitably modified.
- iv. As the services with the highest priority are delivered first and later increments are integrated with them, this arrangement facilitates large-scale and most frequent testing than low priority services which are delivered at the end. Thus, customers are less likely to encounter software failures in the most important parts of the system.

### 7. SKILL SET OF DSS DEVELOPER

There are some important skills that are needed as a professional developer of DSS irrespective of the experience and organizational role. A professional developer of DSS needs to have skills such as extracting information from the DSS users in terms of their requirement from the system. A professional also knows the complexities involved in selection of tools and system design. We shall present here in detail the required skill sets.

i. Understanding the Problem Domain: The DSS developer should thoroughly understand the area of the problem before developing this application. In many cases, the domain experts are needed to give guidance to the DSS developer. Since DSSs are problem centric, it is necessary that both the developer and the user should decide together the specific characteristics of the problem for which DSS is to be built. In this regard, the DSS developer should not only consider the central problem at hand but also have knowledge about the issues surrounding the problem under consideration. It should also be noted that the DSS developer having knowledge about a particular field say medicine may be used for building systems related to it but is not helpful for developing a field completely unrelated to the field of medicine such as manufacturing.

- ii. Understanding Specific User Requirements: In addition to understanding the context of the problem, a developer must also understand the needs and requirements of the users. This understanding includes both the functional aspects of the proposed system and also particular interface requirements for communicating with the system. Thus, before embarking on the actual design, the suggestions need to be sought from the users.
- iii. Understanding the Available Technologies: The DSS system analyst as well as the developer would use their skills and knowledge in harmony to select a DSS tool or platform. A number of technologies are available which can assist the development of particular DSS. For instance, spreadsheet software can be used as a base for the development of a DSS which is used for what-if analysis, whereas a CAD system may be used in case of designing a production facility for manufacturing goods. A developer who has higher expertise in the minute details of the technology would find it easier to select a tool for successful development of DSS.
- iv. Access to Appropriate Knowledge: The expert DSS developer should be able to identify, locate the sources and properly represent the knowledge that is useful for making decisions for a specific problem for which the DSS is being developed. While the identification of the knowledge base applied for making decisions is the responsibility of the analyst and the user jointly, the representation of that knowledge in an appropriate form is the responsibility of the developer. By understanding the problem in an appropriate manner, the representation of the knowledge would be correct and satisfying.

#### SUMMARY

- A team can build a DSS by using the System Development Life Cycle (SDLC) because it requires a large amount of planning and effort. The activities of DSS development process are planning, research, system analysis and conceptual design, construction, design, implementation, maintenance and documentation and adaptation.
- System Development Life Cycle (SDLC) is the sequence of activities that need to be performed in the development of an information system or an application. The activities of SDLC are recognition of need, feasibility study, systems analysis, systems design, implementation, and post-implementation and maintenance.
- ROMC stands for Representations (R), Operations (O), Memory aids (M) and Controls (C). Based on this approach in the design of DSS, the analyst characterizes the various representations available for use as methods of communication between the DSS user and the DSS application.
- Prototyping starts with collecting information or requirements from the customers. Developers and customers interact to define the overall objectives for the software, identify the requirements that the software should satisfy and earmark those areas where further definition is mandatory. Based on these, a "quick design" is made.
- Incrementality principle means that the desired application is produced as a result of an evolutionary process. One approach of applying incrementality principle consists of developing initial subsets of an application and delivering them to the customers.
- The incremental approach to development of DSS facilitates reducing rework in the development process and giving customers some opportunities to delay decisions on their detailed requirements until they gain some experience with the system.
- A professional developer of DSS needs to have skills such as extracting information from the DSS users in terms of their requirement from the system. A professional also knows the complexities involved in selection of tools and technologies.

# <u>Chapter VIII</u> DSS Development Tools

# After reading this chapter, you will be conversant with:

- Tools for DSS Development
- Intrinsic and Extrinsic Tools
- Interface Styles
- Multi-technique Integration of Tools

#### DSS Development Tools

Software that assists in the administration or construction of a DSS is known as a tool. The tool helps in enhancing the productivity of administrators and developers of DSS. One can differentiate between different types of tools in various ways. One can also differentiate between the tools on the basis of the knowledge management technique that is being employed by a tool. The example in this case is the spread sheet and database. There is another way to classify tools wherein some tools can be used to develop generators, while some tools cannot be used to produce other tools as generators. This means that some tools which are used to produce generators are at a higher level compared to those tools which cannot be used to produce generators. The research area has focused on developing high-end tools so as to reduce the difficulties of maintenance and development of low-level tools. High-level tools can be used to incorporate specific features in DSS. A specialized tool is one that can be used to build only certain types of DSS. Such DSS types can handle only certain kinds of procedures, the way in which the procedures can be used, the style or substance of problem statements and presentations, the limitation of the data representation or the means for representing and integrating other types of knowledge. Lotus 1-2-3 comes under the category of specialized tool.

To overcome the limitation of specialized tools, a Generalized Problem Processing System (GPPS) was developed. It is a single piece of software that can be used to construct DSS to solve problems over a wide range of domains. Such FSS would have varying dialog styles with the requirement of various analytical procedures, data and content and can take into its purview various knowledge management techniques. Thus, GPPS is an example of high-level, constant, intrinsic tool. It can act as Problem Processing System (PPS) for different types of DSS because it can get along with various types of Language Systems (LS) and Knowledge Systems (KS) that are developed by developers for assisting various types of decision-making environments.

The notion of a Generalized Problem Processing System (GPPS) was advanced to overcome such limitations. As GPPS is a single piece of software that can be used to develop DSSs across a wide range of problem domains, having diverse dialog styles and contents, requiring very different analytical procedures and data, and accommodating multiple knowledge management techniques. A GPPs is an invariant, high-level, intrinsic tool. It can serve as the PPS for drastically different DSSs because of its ability to work with divergent LSs and KSs devised by developers for providing support in assorted decision settings.

For finding solutions to different types of problems, computer-based DSSs are necessary. And in order to develop computer-based DSSs, tools are necessary. Traditional tools provide only one type of knowledge management technique. Since DSSs require multiple knowledge management techniques to handle different types of knowledge, a single knowledge management technique is suffice or feasible. Thus, DSS which are constructed to serve many purposes in general require new and many types of knowledge management techniques.

One can also differentiate development tools on the basis of interface styles that can be fitted in DSSs. The interface of a DSS is designed in terms of its Language System (LS), Presentation System (PS) and Problem Processing System (PPS). These systems help in assisting, interpreting and packaging and its linguistic knowledge held in the Knowledge Systems (KS). Decision-making process is influenced by the interface. Tools help in the construction of multi-style interfaces which are easy to learn. It is possible to choose an interface based on the task at hand or on the basis of experience.

# **1. TOOLS FOR DSS DEVELOPMENT**

Development tools play an important role in the construction of DSSs. The tools that are selected for developing a particular DSS have their influence not only on the process of development but also the features that DSS offers after its construction is completed. The tools that are available can be inspected from

different key points that would increase our understanding of the influence that these tools exert on the process and product of DSS development. Different tools are geared towards one or the other knowledge management techniques. In the other way round, a given technique or its possible variants is offered by more than one development tool. Therefore, it is possible for us to classify the tools on the basis of knowledge management techniques that they provide. For instance, spreadsheet tools offer spreadsheet technique of knowledge management, while a database tool provides some version of a database technique for managing knowledge and so on. It is also possible that spreadsheet tools can not only implement spreadsheet techniques but also graphical techniques. In the matter of selecting tools related to the category of techniques, on must take into account the technique that is stressed upon, whether the tool fits into multiple categories, the assistance provided by the tool in the analysis and design stages and the role of the tool in implementation.

There are a number of development tools available in DSS which help in specific decision-making. Examples of such tools are spreadsheet management or text management is generally made use of in business-computing desktops. Multiple tools are also being deployed providing more than one capability such as spreadsheet, text and graphical presentation techniques. In addition to these, there are more advanced tools, known as DSS generators, used in complex DSS applications. In the subsequent sections, we shall consider the various tools and also their classification.

#### 1.1 Classification of Development Tools

There are different ways to classify development tools. Some methods are based on the development techniques, while others are based on the activity undertaken or the use to which the tool is put during the process of DSS development. In addition, there are tools which are classified according to the type of interfaces that it generates. Understanding of the various available tools would help a end-user as well as a professional developer in the construction of a platform for further development work. Following is the classification of the development tools based on the three levels of technology: (i) DSS primary development tools, (ii) DSS generators, and (iii) Specific DSS applications.

There are also integrated tools such as Excel which are used for a general purpose DSS system. They provide a set of capabilities to build a specific DSS. The examples of capabilities include modeling, report generation and graphic display. Microsoft Office suite can also be used for generating DSS and also for other purposes. The sub-tools in an integrated DSS tool package include spreadsheets such as MS-Excel, data management software such as MS-Access, word processing software such as MS-Word, Internet browsers such as Netscape navigator, graphics software such as MS-Powerpoint, calendar/time management applications and project management applications.

#### **1.1.1 DSS PRIMARY DEVELOPMENT TOOLS**

As the name suggests, primary development tools are employed for the simplest tasks undertaken with the help of DSS. Examples of such tools are the programming languages, random number generators. code and text editors, graphics development applications and query languages applied to extract information from the databases. These tools are used to create specific and integrated DSS tools.

### **1.1.2 DSS GENERATORS**

One must consider the literal meaning of DSS generators because generators do not "generate" anything. Most of the time, it is only an integrated set of tools and functions that helps in the implementation of DSS. A DSS generator is a software/hardware system useful in a particular situation and is a part of a decision process. A generator may be an integrated package of software that provides a set of features to construct a DSS quickly, without much cost and in an easy manner. A DSS is an integrated and easy-to-use package having wide varieties of capabilities such as modeling, report generation and graphical presentation useful in analyzing risk. An ideal DSS generator may be a special-purpose language. This special-purpose language can be used to construct a DSS application or an integrated software system based on the spread technology.

They may include information systems application whose characteristics differ from data processing applications. Specific hardware/software allows a unique decision-maker or group of them to solve a particular set of related problems. Examples of DSS generators include MS-Excel that is commonly used on Desktop PCs and more advanced and expensive applications such as MicroStrategy's DSS Agent. MS-Excel is a highly advanced DSS application development environment and hence can be considered a DSS generator even though many people use only a small fraction of Excel's capabilities.

Irrespective of the degree of sophistication, all DSS generators have integrated and diverse functionality which help in decision modeling, report design and also production and presentation of graphics and database management facility. A DSS generator in the form of a software package is helpful for developing the user interface, a model or a database schema for a DSS.

The objective of a DSS generator is to allow hurdle-free development of a wide variety of specific DSS and a flexible generator with the capability of changing according to the situation would help in the iterative design process which would help DSS to respond to situations in the shortest possible time. Wide varieties of DSS generators are used in DSS. For instance, there are DSS generators for developing a specific data-driven DSS, while there are generators for constructing a model-driven DSS.

The advantage of DSS generators over primary development tools is that generators offer convenience. There is no need to take into account issues such as integration among the tools, access multiple tools, import and export of data and non-standardized command structures across tools. DSS generator permits tight coupling among the various functions of the DSS generator which facilitates the developer to put his/her attention on the design process rather than meddle with the tools.

Let us consider the following DSS tools in the computer hardware which are together known as DSS generators.

- i. Material Requirement Planning (MRP): Material Requirement Planning is defined as a process for determining the amount of raw materials, labor and machine requirement necessary to manufacture a specified number of products. It is a method for ordering and maintaining materials in stock. Under MRP, a systematic approach is used to identify cost beneficial ways of storing materials.
- ii. Linear Programming: This tool assists in the allocation of constrained resources and finding of alternatives to reach the objectives. It is a mathematical technique that can be used to obtain optimum solution for those problems which involve resource allocation in the field of planning for production.
- iii. Queuing Theory: This is a stochastic process used to plan the production of goods in an order which is economically beneficial. The production of goods is lined up in a queue or waiting lines. It is also applied to the problems involving traffic congestion and storage systems.
- iv. **Descriptive Statistics:** It deals with the presentation of data in the form of tables and charts in a summarized form by means of percentiles and standard deviations. Descriptive statistics are used to estimate parameter and the dispersion of values associated with the parameter. It is used to plan for every day operations of an organization.

- v. **Correlation Analysis:** Correlation measures the strength of the relationship between two variables. Correlation analysis is made to calculate the relationship between values for particular parameters, such as parameter values describing current condition. For instance, there exists positive correlation between cigarette smoking and incidence of lung cancer. That is both cigarette smoking and incidence of lung cancer move together in the same direction.
- vi. Variance Analysis: This analysis determines how much the difference (variance) between two or more variables is an analysis of variation in the outcome of an experiment is done to find out the contribution of each variable to the variation.
- vii. **Network Analysis:** It is an analytic technique that can be used in project planning to find out the sequence of activities and their interrelationship within the network of activities undertaken for the completion of the project. This analysis assists managers in planning and controlling tasks that are necessary for successful operation of the organization.
- viii. **Transportation Problems:** It is a programming problem that is used to plan and determine optimal distribution of various goods, facilities and resources from several points of origin to many distinct destinations based on the specific requirements at each destination.
- ix. **Dynamic Programming:** It is a mathematical technique that can be used to solve multidimensional optimization problems. This tool ensures that the course of action and decisions taken by the top management personnel are being followed by the operational managers.
- x. **Regression Analysis:** It deals with relationship between two or more variables. One is the dependent variable and another one is the independent variable. Regression analysis consists of determining the value of dependent variable on the basis of the value of independent variable.
- xi. **Multi-dimensional Scaling:** It is a family of statistical methods in which information contained in a data set is represented by means of set of points in multidimensional space. It is tool for transforming one-dimensional expressions of relationships into multi-dimensional expressions of these same relationships.
- xii. **Markov Processes:** It is a stochastic process which assumes that in a series of random events the probability of occurrence of each event depends only on the immediately preceding outcome. The tools of these processes are used to determine global probabilities associated with the occurrence of events related to changing propensities of particular object.
- xiii. **Maximum Flow or Distance:** This is a tool which identifies the most economically beneficial flow or the distance between particular objects. After determining the distance, it would be possible to determine the most preferred flow of goods or services through an area or object for which the organization is conducting business.

#### **1.1.3 SPECIFIC DSS APPLICATIONS**

The third level is the specific DSS application which can be in the form of a commercial DSS package or a final product that is capable of completing the task of DSS. It is easier to acquire a commercially developed DSS application instead of developing it in-house. For instance, a DSS may be constructed on a commercial scale for the use of medical fraternity. It incorporates vast knowledge of medicine that can be commonly applied to the entire human race. Acquiring such a general purpose DSS in the medical field can help in the treatment of diseases or illness of patients easily and economically. DSS tools can be used to construct DSS generators which in turn can be used to build DSS applications. A commercial DSS generator can also be used to develop a wide variety of specific DSS applications.

# 2. INTRINSIC AND EXTRINSIC TOOLS

DSS tools differ by the roles that they perform in the development process. Following are the tools:

- i. An Intrinsic Tool: Intrinsic tools are the software those that become a part of the DSS when it is constructed and assist the developer thereby saving his time spent on programming. An interface engine or the Lotus 1-2-3 software are the examples of intrinsic tools. This will serve as the Problem Processing System (PPS) of the DSS being developed. In this, developer initializes the KS. It is widely used in Excel, Lotus 1-2-3, etc.
- ii. **Partially Intrinsic Tool:** This will serve as a part of the DSS's problem processing system. In this, developer designs or implements rest of PPS. It is widely used in Dbase, Access, etc.
- iii. **An Extrinsic Tool:** Extrinsic tools are the software those that are external to the DSS or they can be considered to have been administered with DSS. A text editor and an induction mechanism that is used to spell out the rules of an expert system are the examples of extrinsic tools. This tool does not participate in any part of PPS. An extrinsic tool helps the developer produce all or part of the PPS or to create some portion of the KS contents.

# **3. INTERFACE STYLES**

The preference for interface styles that can be built into DSS differ from one user to another. Most of the time users want a friendly DSS. The user friendliness of an interface depends on the nature of the problem, type of the task that the DSS needs to perform and the capability of the user or the type of the user. Preference for an interface depends on the task and the experience of the user. For a user, the interface should be compatible to the task at hand and should be adaptable. It should be easy to learn. The interface should not be a major problem when a user takes up another task. The users should perceive that they are in control of the system while using the interface. It has also been found that interface has an influence on the decision-making process.

In order to enhance the processing speed of users, reduce errors, enlarge productivity and give a perception to the users that they are in control of the system, it is necessary to design user interface is an appropriate manner. The quality of DSS interface is dependent upon the view of the user and his feelings about the interface, the actions that the user needs to take in order to obtain the desired results. Thus, to create a user interface that is ideal, convenient and acceptable to the users, MIS professionals should cooperatively work with potential users to understand their point of view. They should try different designs for obtaining solutions and provide users to appropriate control over the way the system performs. Since this approach gives priority to the needs of the users, it is known as User-Centered Design. Following are the seven issues that are prominent in the construction and evaluation of a user interface:

- i. User Interface Style It should be noted that the style or combination of styles be appropriate in the user interface.
- ii. **Design of Screen and Layout** The question here is the selection of the design and the approach to design. The design should not only be attractive but also easy to understand. It should be well-balanced.
- Use of Colors, Lines and Graphics The use of colors should be appropriate. The use of graphics should bring about an improvement in the design.
- iv. Volume of Information The amount of information that is to be presented on the screen should be appropriate. It should be possible for the users to control the density of information.

- v. Use of Icons and Symbols The icons should convey the meaning they are intended for.
- vi. Choice of Input and Output Devices The devices used for input and output should be appropriate for the task hand.
- vii. **The Interaction between Human and Software –** The interaction between the user and the software should be logical and based on institution.

Managers and DSS analysts should focus on the above mentioned issues while evaluation is carried out in a systematic manner, it will improve its effectiveness and usage.

It is the user interface that determines the entry of information and its display. The ease and comfort in learning and using the system is dependent on the interface. The four generally used styles which determine the interaction with computerized information systems are: command-line interfaces, menu interfaces, point-and-click graphical interfaces and question-and-answer interfaces. Most often these interface styles can be combined in a productive manner into a single application or a set of related applications. It is highly appreciated if the designer makes available various ways to perform the same task. The input devices that can be used to manipulate these four general interface styles are keyboard, mouse, touch pad and voice inputs.

Now, let us study the features of these four user interface styles in detail:

- i. **Command-line Interfaces:** This is the oldest and widely prevalent interface that is still used in MS-Dos. UNIX and Linux operating systems. In the usage of command-language style interface, a user enters a command such as "run" or "plot". Many commands are a combination of verb and noun. For instance, "plot sales". In Command-line interfaces, a user enters a command to give an instruction to the system to carry out a task. The user is responsible for selecting a command or a combination of commands. He should also know the function performed by the command that is selected. However, it is difficult to learn commands and remember their functionality.
- ii. Menu Interfaces: In this type of interaction, a user selects from a list a set of choices to perform a task. This ordered list of functions or tasks is known as menu. It is possible for a user to make a choice among items by manipulating an input device or entering a menu item number. A menu contains submenus. Hence, it is necessary that menus should appear in a logical and hierarchical order with main menu occupying priority and submenus coming in order after that. A pull-down menu is a submenu that appears as a superimposed drop-menu on a screen, usually after an entry has been made in a higher-level menu. Another variant of menu interface is a tool bar with graphical icons. The advantage of using menus is that there is no need to remember and only upon seeing the menu on the screen one can known the function it performs. While designing menus, designers should take balance the needs of both experienced and amateur users.
- iii. Graphical Interfaces: A Graphical User Interface (GUI) makes it possible for the users to have direct and complete control over the objects that are visible on the screen. Just by pointing and clicking on the objects, users can initiate actions. Thus, there is no need to remember the commands. The operating systems that are based on GUI are Windows and Macintosh OS. The prominent GUI elements are windows, icons, pull-down menus and dialog boxes. In GUI-based systems, icons represent tiny pictures, clicking on them causes actions. User interfaces can also have multimedia and hypermedia technologies.

iv. Question-and-Answer Interfaces: This interface is in the form of a dialogue with the computer asking the question and the user answering it. The answer is in the form of a phrase or a sentence. The questions posed by the computer depend upon the previous responses of the user and the requirements needed for processing an application. Another form of interface style is known as form interaction in which the user enters data or commands into designated spaces (fields) contained in a form. Based on the heading of the form, the desired input is entered. A natural language dialogue between human and computer is another variant and can be compared to the dialog between one human being and another. The limitation of the natural language dialogue is that the computer may not understand unstructured unique natural language. It is the responsibility of the programmer to anticipate user answers and response from the program.

Most of the time DSS end users do not have high degree of computer literacy. They are employed on the basis of some skill set that they possess. DSS end users can exercise individual knowledge and skills to a higher degree when compared to knowledge workers. The types of decisions that DSS end users make has a profound impact on the performance of an organization when compared to knowledge workers. It is necessary that the personal preferences of DSS end users should be taken into account while designing DSS that make particular decisions.

### 4. MULTI-TECHNIQUE INTEGRATION OF TOOLS

It is necessary to integrate DSS into an organization's computing infrastructure because there are a number of other information systems such as expert systems, executive information systems, data mining applications etc., which are also present. Hence, DSS cannot operate in isolation. This integration would help a user to work at ease and this would contribute to the success of DSS implementation. Synergy can be achieved by integrating DSS with other information systems. This means that various information systems can use different kinds of models and exchange data amongst their various applications. Various tools can also be integrated so that the user can focus his attention on using each of the tools to achieve desired objective.

Two kinds of DSS integration are possible. They are: functional integration and physical integration. In functional integration, the various functions that DSS carries out can be integrated and joined to the infrastructure that is already present. This linkage would help in determining common menu access, inter – and intra-application transfer of data and tools and a common application interface at the same desktop client or workstation. This would make it possible for single or multiple users to access all available organizational decision support mechanisms and resources on demand.

Sometimes the design of integration is given preference over the actual implementation of DSS. This is because it will help in determining which DSS tools need to be employed and the type of software platforms that are required for development.

Multi-technique integration of tools is used in the construction of the DSS. This is acceptable whenever different knowledge management techniques are used in a single DSS. The techniques may be integrated within a single tool or across multiple tools. Various integration styles have their own advantages and disadvantages with respect to one another. More than one style may be used in a single DSS. These tools involve knowledge, knowledge manipulation, program and knowledge transfer from one storage to another.

i. **Integration via Knowledge Conversion:** This involves conversion utility or facility for import/export. The number of utilities will increase with the increase in the number of programs. The transfer of knowledge involves time and effort. Manipulation of knowledge requires program switching. Problem

Processing Systems (PPSs) are developed to take up transfers and switching. Redundancy can lead to consistency problems. This can be represented in the form of a figure 1.



Figure 1: Integration via Knowledge Conversion

ii. Integration via a Clipboard: A clipboard is a software program that can be used to copy or move data/information from one location to another. The use of clipboard is very easy. One only needs to select the text, image or any other item that needs to be copied or moved from one place to another. The item chosen is first copied to the clipboard and then it is pasted at any desired location. A clipboard is the most common item of the Graphical User Interface (GUI) environment. The items which are copied are held temporarily in the clipboard. The operations that can be implemented with the help of a clipboard are Cut, Copy, Paste and Delete. It is convenient for a user to use a window called clipboard viewer that displays the current contents of the clipboard. The integration via clipboard is shown in figure 2.



Figure 2: Integration via a Clipboard

iii. **Integration via a Common Format:** In this type of integration, all programs are designed to manipulate common format. There is no requirement of knowledge transfer. There is still need for program switching. But, the redundancy or consistency problems are reduced. However, it is not easy to put in place a single format for wide software functionality. The integration via common format is shown in figure 3.



iv. **Integration via Nesting:** Varied software functionalities can be bonded together through knowledge. The other way is to put together different techniques into a single tool. One of the ways is to join together different

capabilities into a single program. A prominent component and secondary components perform switching among programs. There is no need of knowledge transfer. The integration via nesting is shown in figure 4.



v. **Synergistic Integration:** Here, there is a single program without a dominant functionality. This can be used independently. Since this can make use of different techniques in a single operation, the dividing lines among various techniques become irrelevant. Here, there is no disadvantage of using a single format.

**Figures 5: Synergistic Integration** 



#### SUMMARY

- Software that assists in the administration or construction of a DSS is known as a tool. The tool helps in enhancing the productivity of administrators and developers of DSS. One can also differentiate between the tools on the basis of the knowledge management technique that is being employed by a tool.
- A GPPS is a single piece of software that can be used to develop DSSs across a wide range of problem domains, having diverse dialog styles and contents, requiring very different analytical procedures and data, and accommodating multiple knowledge management techniques.
- Development tools play an important role in the construction of DSSs. The tools that are selected for developing a particular DSS have their influence not only on the process of development but also on the features that DSS offers after its construction is completed.
- There are different ways to classify development tools. They are DSS primary development tools, DSS generators and specific DSS applications. There are also integrated tools such as Excel which are used for a general purpose DSS system. They provide a set of capabilities to build a specific DSS.
- A DSS generator is a software/hardware system useful in a particular situation and is part of a decision process. A generator may be a integrated package of software that provides a set of features to construct a DSS quickly, without much cost and in an easy manner.
- DSS tools differ by the roles that they perform in the development process. Different tools are intrinsic tools, partially intrinsic tool and an extrinsic tool.
- The four user interface styles are: Command-line interface, menu interface, graphical interface and question-and-answer interface.

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# Glossary

Abstract System	:	It is the name which signifies no tangible existence. It is only an orderly arrangement of interdependent ideas or constructs.
Adaptive	:	A system which changes its response due to changes in the environment is known as adaptive system.
Aggregation	:	It is a functional category which involves creation, or derivation of summary statistics, such as averages or totals.
Application Software	:	It consists of programs that direct processing for particular use of computers by end-users such as a sales analysis program, and a pay-roll program.
Analytical Databases	:	These databases contain data and information extracted from selected operational and external databases.
Batch Processing	:	It is a procedure whereby a user gives a computer a batch of information, referred to as a job for example, a program and its input data on punched cards and waits for it to be processed as a whole.
Business Process Reengineering (BPR)	:	Business process reengineering is a management approach aiming at improvements by means of elevating efficiency and effectiveness of the processes that exist within and across organizations.
Clipboard	:	It is a software program that can be used to copy or move data/information from one location to another.
Character	:	It is the most basic logical data element that consists of a single alphabetic, numeric or other symbol.
Control Process	:	It is a relationship between superiors and subordinates wherein superiors communicate the goals of an organization to the subordinates and subordinates devise strategies to achieve them.
Coordination and Integration Mechanisms	:	Organizations need specific vehicles for communication to help in coordination, decision-making, conflict resolution and development of commitment and trust among the employees.
Computer-Aided Software Engineering (CASE) Tools	:	They are automated tools used to design databases and application programs.
Control System	:	It is a formal and informal systems to assist the management in steering the organization and its employees towards its goals.
Database	:	It is a collection of data stored on a computer storage medium in a common pool for access on an as needed basis.
Data Display	:	DBMS provides the facility for the user to view data in the database. It provides a facility known as a view mechanism which allows each user to have his/her own view about the database.
Data Integrity	:	The integrity system maintains the consistency of stored data.

Data Manipulation Language	:	The Data Manipulation Language (DML) provides the facility for the users to Insert, Update, Delete and Sort data in the database.
Data Resources	:	It refers to databases that hold processed and organized data.
Data Warehouse	:	A data warehouse is a central repository for all or significant parts of the data that are collected by various business systems of an enterprise.
Decision-Making	:	It is an activity of producing a new piece of knowledge that indicates a certain level of commitment to some course of action.
Deterministic Systems	:	These are predictable systems where the output can be predicted based on the input and type of process.
A Decision Support System (DSS)	:	It is a computer program application that analyzes business data and presents it such that users can make business decisions more easily.
Data Mining	:	In data mining, data from the data warehouse database is processed to find out or identify any underlying pattern of business activity.
Data Warehouse	:	A large specialized database, holding perhaps hundreds of terabytes of data. A database specifically structured for information access and reporting.
Direct Manipulation	:	It means that requests can be made by manipulating system presentations of objects. LS assists users in manipulating Presentation System (PS) elements.
Distributed Database Management System (DDBMS)	:	It consists of a single logical database that is split into a number of fragments. Each fragment is stored on one or more computers under the control of separate DBMS, with the computers connected by a communications network. of local autonomy and is also capable of processing data stored on other computers in the network.
DSS Generator	:	It is a software/hardware system of use in a particular situation and is part of a decision process.
Electronic Data Interchange (EDI)	:	It refers to the exchange of business transaction documents using directly linked computers between two organizations.
Electronic Bulletin Board	:	It is an electronic message center.
Electronic Commerce	:	It is an electronic communication among enterprises, including customers, suppliers, business partners, government organizations, and financial institutions.
Effectiveness	:	It is the measure of the extent to which a system achieves its goals.
Efficiency	:	It is a measure of the total output generated divided by total input consumed and is expressed as a percentage ranging from 0 to 100 percent.
Equalization	:	It is a functional category which involves, creation of knowledge regarding conditions necessary to maintain consistency within the problem consistency.
E-mail or Electronic Mail	:	It refers to the transmission of messages over communications network.

End-users	:	They are people who use information products for their varying needs. They can be accountants, salespersons, engineers, clerks, customers, or managers.
Environment	:	The world outside the system is called the environment.
Error Detection	:	It is a process which involves checking the appropriate format (text, numbers etc) of input data, length of the numeric data, validity of the data, consistency of the data.
Estimation	:	It is a functional category which involves, creation of model parameter estimates.
Executive Information System	:	An Executive Information System (EIS) is a type of management information system intended to facilitate and support the information and decision-making needs of senior executives by providing easy access to both internal and external information relevant to meeting the strategic goals of the organization.
Extranet	:	An extranet is a private network that uses Internet technology and the public telecommunication system to share part of a business's information or operations with suppliers, vendors, partners, customers, or other businesses in a secured environment.
Expert System	:	A program that uses available information, heuristics, and inference to suggest solutions to problems in a particular discipline.
External Knowledge	:	It is the knowledge of competitors, external products, markets and business intelligence.
Extranet	:	An extension of an institution's intranet, especially over the World Wide Web, enabling communication between the institution and people it deals with, often by providing limited access to its intranet.
Extrinsic Tools	:	These tools are external to the DSS or they can be considered to have been administered with DSS.
Factor Analysis	:	It is an analysis which helps in identifying the organizational variables which are latent, yet contribute to the success of the organization.
Feasibility Study	:	A feasibility study can be defined as a preliminary study that investigates the information needs of prospective users and determines the resource requirements, costs, benefits, and overall feasibility of a proposed project.
Field	:	This is a single piece of information as it consists of a group of characters.
File	:	A file or a table is a collection of group of related records.
File Transfer Protocol (FTP)	:	It is a protocol which helps the Internet user to download data files, programs, reports, articles, magazines, books, pictures, sounds and other types of files from thousands of sources to his/her computer system.
Financial Information Systems	:	It is a system that collects data relating to the financial activities in an organization and processes this data to bring out that information which is useful for making decisions.
Formal Control System	:	It consists of subsystems such as management style and culture of the organization, infrastructure, rewards, coordination and integration and control process.

Functional Category Analysis	:	In this analysis, the developer identifies the specific functions necessary for a specific DSS from a broad list of available functions.
Functional Form	:	In an organization, a number of functions are performed like marketing, production, finance, purchasing, technical and accounting. Each function has its own information system which caters to the needs of the managers of that functional area.
Generalized Problem Processing System (GPPS)	:	It is a single piece of software that can be used to develop DSSs across a wide range of problem domains, having diverse dialog styles and contents, requiring very different analytical procedures and data, and accommodating multiple knowledge management techniques.
Graphical User Interface (GUI)	:	It is an interface for issuing commands to a computer utilizing a pointing device, such as a mouse, that manipulates and activates graphical images on a monitor.
Group Decision Support Systems (GDSS)	:	A GDSS system is an interactive, computer-based system that facilitates solution of unstructured and semi- structured problems by a set of decision-makers working together as a group.
Hardware Resources	:	Hardware resources include all physical devices and materials used in information processing.
Hierarchical Classification of an Organization	:	It comprises three levels in an organization – operational, tactical, and strategic.
Hypertext Database	:	It is a picture, text or a film can be linked to another picture, text or a film.
Incrementally	:	It defines a process which moves along in a step-wise fashion, in increments.
Indicator	:	It is a term used to understand an organization's current state of affairs and for initiating corrective action.
Informal Control Systems	:	An informal control system contains the subsystems such as recognition and rewards, informal coordinating mechanisms, style and culture and informal control process.
Informal Coordinating Mechanisms	:	It refers to the networks of relationships that emerge as a result of socialization and mutual adjustment by the employees.
Infrastructure	:	The infrastructure of an organization refers to its structure and the patterns of its autonomy. Patterns of autonomy include designations of responsibility and the methods of measuring task accomplished.
Integration Via Knowledge Conversion	:	This involves conversion utility or facility for import/export. The number of utilities will increase with the increase in the number of programs. The transfer of knowledge involves time and effort.
Interface	:	Is a component designed to allow the user to access internal components of a system.

Internet worked Enterprise	:	An internetworked enterprise uses the Internet, intranets, extranets and other networks to support every step of the commercial process. This may include everything from multimedia advertising, product information and customer support on the World Wide Web, to Internet security and payment mechanisms that ensure completion of delivery and payment processes.
Intranet	:	A privately maintained computer network that can be accessed only by authorized persons, especially members or employees of the organization that owns it.
Intrinsic Tools	:	They are the software those that become a part of the DSS when it is constructed and assist the developer thereby saving his time spent on programming.
Knowledge Base	:	It is a repository of information stored by the DSS.
Knowledge Engine	:	It performs functions such as recognizing a problem and finding an interim or final solution in addition to other functions related to the management of the problem- solving process.
Knowledge Management Systems (KMS)	:	They are communications systems designed to facilitate the sharing of knowledge rather than just information.
Knowledge System (KS)	:	It is a representational system containing all readily changeable knowledge available to the DSS for use in problem solving and communicating.
Knowledge Work Systems (KWS)	:	They are the information systems that aid knowledge workers in the creation and integration of new knowledge in the organization.
Key Variable or Key Success Factors	:	It is a significant indicator of business activity, whose sudden and unpredictable change warrants immediate action by management.
Language Systems (LSs)	:	Language System (LS) is present to manage the input. When using this system, the user inserts data and chooses the model that is to be applied. LSs are not software. It is a representational system consisting of different requests a user can make to have DSS solve a problem.
Mathematical Model	:	It is the one where the representation is in the form of a mathematical concept involving constants, variables, functional relationship and constraints.
Management Control	:	The process by which managers assure that the resources are obtained and used efficiently and effectively in the accomplishment of the organization's goals.
Management Control System	:	It is a plan that for the procurement of resources and their use in an efficient and effective manner in order to reach the goals set for an organization.
Management Information System (MIS)	:	It is a term which refers to a computer-based system that provides managers with the tools for organizing, evaluating and efficiently running their departments. It is an integrated man-machine system that provides information to support the planning and control functions of managers in an organization.
Model	:	It is an object or a concept that can be used to represent a practical situation such as a physical machine or a system.

Model Base	:	It is a collection of different types of models that are contained in an electronic storage medium and accessible to users and programs.
Model Base Management System (MBMS)	:	Models are used by decision-makers to convert data into useful information.
Modeling Language	:	It is a language which facilitates the creation of decision models and also provides a mechanism for linking multiple models that helps in sequential processing and data exchange. There is also a provision for the user to modify models so as to bring about specific preferences.
Multivariate Analysis	:	It is analysis which can be applied to identify the critical control variables and underlying factors, in the field of management control.
Multi-dimensional Structure	:	This structure is a variation of the relational modeling which multi-dimensional structures are used to organize data and express the relationships between data.
Natural Language Interaction	:	The interaction of users with computer systems through the medium of natural languages.
Natural Language Interface	:	Natural Language Interfaces: These interfaces accept requests written in English, Hindi or some other language and attempt to "understand" them. A natural language interface usually has its own "schema," which is similar to the database conceptual schema, as well as a dictionary of important words.
Online Analytical Processing (OLAP)	:	Online Analytical Processing is an approach to quickly provide answers to analytical queries that are multi- dimensional in nature.
Operational IS Planning	:	This type of planning is done on a short-term basis to implement and control day-to-day operations. It involves detail plans to achieve new information systems development projects which include preparation of operating budgets.
Operational Databases	:	These databases are helpful in carrying out the operations of the organization. They are also known as Subject Area Databases (SADB), transaction databases and production databases.
Optimization	:	It is a functional category which involves discovering what set of parameter values best meet a set of performance measures within a set of defined constraints.
Optimization Analysis	:	It is a complex extension of goal-seeking analysis. Instead of setting a specific target value for a variable, the goal is to find the optimum value for one or more target variables, given certain constraints.
Presentation System (PS)	:	It performs the function of managing the output produced by DSS. The output is presented in the form of schedules, graphs, thematic tables.
Problem Processing System (PPS)	:	It is the DSS software that reacts to user requests and brings out a corresponding response to the problem.
Probabilistic or Stochastic Systems	:	In these systems, some conditions of the system can be predicted from the previous state but only in terms of probable behavior and hence there is always a certain degree of error in the prediction.

Procedures	:	It refers to operating instructions for the people who will use an information system such as instructions for filling out a paper form or using a software package.
Process Variables	:	It refers to the processes that influence the behavior of the employees towards the achievement or organizational goals.
Prototyping	:	It is the process of quickly putting together a working model (a prototype) in order to test various aspects of a design, illustrate ideas or features and gather early user feedback.
Query Language	:	It is a generalized computer language that is used to interrogate a data base.
Representations Operations Memory aids and Controls Analysis (ROMC)	:	It is an alternative to SDLC the analyst characterizes the various representations available for use as methods of communication between the DSS user and the DSS application.
Record	:	A record is a collection of related fields of data which are grouped together. A record represents a collection of attributes that describe an entity.
Relational Database Management System (RDBMS)	:	A Relational Database Management System (RDBMS) is a Database Management System (DBMS) that is based on the relational model as introduced by E. F. Codd.
Repository	:	It is the centralized knowledge base for all data definitions, data relationships, screen and report formats and other system components.
Selection	:	It is a functional category which involves, locating knowledge within the knowledge base for use as input to the new knowledge derivation process.
Self-Organizing Systems	:	Self-organizing systems are those which adapt and react to inputs or stimuli.
Stable and Dynamic Systems	:	A stable system is one which experiences very little change over time.
Sensitivity Analysis	:	It is the special case of what-if analysis. Even though a number of variables affect a given situation, but in this case only one variable is changed a number of times to determine the effect of change each time on other variables.
Short-range Planning	:	It is a plan done for a very short period of time usually for a day, week or month.
Simulation	:	It is a functional category which involves, creation of knowledge about expected outcomes or consequences of specific actions within the organizational environment.
System Development Life Cycle	:	The sequence of events in the development of an information system (application), which requires mutual effort on the part of the user and technical staff. See agile software development and information processing cycle.
Structured Internal Knowledge (Explicit Knowledge)	:	It is in the form of product manuals or research reports.
Strategy Variables	:	Refer to the long-term choices concerning the programs, goals, policies, and action plans that are formulated by an organization.

Structural Variables	:	It is in terms of the structure of the organization: centralized or decentralized form of organization, and the organizational autonomy.
Strategic Information Systems Plan (SISP)	:	It identifies the information systems and technologies required to support the business strategy identified in the strategic business plan.
System	:	A group of interacting, interrelated, or interdependent elements forming a complex whole.
Systems Analysis	:	It is the detailed study of various operations performed by a system and their relationships within and outside of the system.
Systems Design	:	It consists of activities that produce specifications that satisfy the functional requirements of an information system developed in the systems analysis stage.
System Development Life Cycle (SDLC)	:	It is the sequence of activities that need to be performed in the development of an information system or an application.
Synergism	:	When all the departments are integrated, then the output produced by the organization is more than the sum of the output produced by each department working in isolation. This is known as principle of <i>synergism</i> .
Tacit Knowledge	:	It is also known as informal internal knowledge. It resides in the minds of business executives. It is an asset gained by them through years of experience, social interaction, sharing and practice. It is not documented and has no fixed pattern.
Tactical IS Planning	:	It involves the design of tactics, setting of objectives and the development of procedures, rules and schedules and approving budgets. It is the last stage of planning process.
Transaction Processing System	:	A system which processes predefined transactions, one at a time, with direct, on-site entry of the transactions into a terminal, and which produces predefined outputs and maintains the necessary data base.
User Interface	:	It is the way a person interacts with a computer or electronic device. It comprises the screen menus and icons, keyboard shortcuts, command language and online help, as well as physical buttons, dials and levers.
User System Interface	:	It is the term that is used to cover all aspects of system design that affect the usage of the system.
What-If Analysis	:	What-If Analysis helps in analyzing the alternatives generated by the models. This analysis is used to determine the impact of changes when inputs or outputs are increased, decreased or changed.
Working Capital Turnover	:	The efficiency of management of working capital is indicated by the working capital turnover. The inventory turnover and accounts receivables turnover can also help in the analysis of working capital.
World Wide Web	:	It is a way or a medium for accessing, or publishing information and running business applications on the Internet in an easy way to use form on the Internet.