INFORMATION TECHNOLOGY AND HUMAN RESOURCE INFORMATION SYSTEM

M.A (H.R.M)
Semester-III, Paper-IV

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M.A. (H.R.M): Information Technology And Human Resource Information System (IT & HRIS)

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FOREWORD

Since its establishment in 1976, Acharya Nagarjuna University has been forging ahead in the path of progress and dynamism, offering a variety of courses and research contributions. I am extremely happy that by gaining 'A' grade from the NAAC in the year 2016, Acharya Nagarjuna University is offering educational opportunities at the UG, PG levels apart from research degrees to students from over 443 affiliated colleges spread over the two districts of Guntur and Prakasam.

The University has also started the Centre for Distance Education in 2003-04 with the aim of taking higher education to the door step of all the sectors of the society. The centre will be a great help to those who cannot join in colleges, those who cannot afford the exorbitant fees as regular students, and even to housewives desirous of pursuing higher studies. Acharya Nagarjuna University has started offering B.A., and B.Com courses at the Degree level and M.A., M.Com., M.Sc., M.B.A., and L.L.M., courses at the PG level from the academic year 2003-2004 onwards.

To facilitate easier understanding by students studying through the distance mode, these self-instruction materials have been prepared by eminent and experienced teachers. The lessons have been drafted with great care and expertise in the stipulated time by these teachers. Constructive ideas and scholarly suggestions are welcome from students and teachers involved respectively. Such ideas will be incorporated for the greater efficacy ofthis distance mode of education. For clarification of doubts and feedback, weekly classes and contact classes will be arranged at the UG and PG levels respectively.

It is my aim that students getting higher education through the Centre for Distance Education should improve their qualification, have better employment opportunities andin turn be part of country's progress. It is my fond desire that in the years to come, the Centre for Distance Education will go from strength to strength in the form of new courses and by catering to larger number of people. My congratulations to all the Directors, Academic Coordinators, Editors and Lesson- writers of the Centre who have helped in these endeavors.

Prof. P. Raja Sekhar
Vice-Chancellor
Acharya Nagarjuna University

M.A (H.R.M) Semester-III

Paper-IV

304HM21 - INFORMATION TECHNOLOGY AND HUMAN RESOURCE INFORMATION SYSTEM (IT & HRIS)

SYLLABUS

UNIT-I

Information Technology and Business: Information Systems; Introduction to Computers: Origin, Development and Importance of Computers; Generation and Classification of Computers.

UNIT-II

Input and Output Devices: Storage Devices; Central Processing Unit; Computer Configuration; Binary System and Data Representation; Hardware and Software.

UNIT -III

Introduction- MIS Application Framework (Model)MIS Operations (Production) MIS Materials, Human Resource Management, Financial Management, Marketing, Management, Hotel Management System, Banking System

UNIT-IV

Manager's Role in Decision Making, Types of Decision, Conceptual Models of Decision Making The Process of Decision Making, Herbert Simons Model of Decision Making, Group Decision Making, Characteristics of a DSS, Capabilities of DSS, Decision Making Levels, Integration of TPS, MIS, and DSS, Components of a DSS, Group Decision Support System, Decision Making Tools, Decision Tables, Decision Tree, Principle of Rationality, Role Play, Models for Decision Making

UNIT-V

Data Cycle, Database Design, Database Languages, Types of Database Management System Networking, Network Topology

Prescribed Books:

1.Jawadekar, W.S, : Management Information Systems, Tata McGraw-Hill Co. New Delhi .

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CONTENTS

LESSON -1

INFORMATION TECHNOLOGY AND BUSINESS

Learning Objectives

- ✓ To study the characteristics of Information
- ✓ To Learn the Importance and Advantages of IT in business
- ✓ To Know the Information Technology in different areas of business
- ✓ To Understand the Demerits of E-business
- ✓ To Outline the Characteristics of Computer
- ✓ To exemplify the Components and Limitations of Computer system

Structure

1.1 Introduction

According to Attaran, "Information technology is defined as capabilities offered to organizations by computers, software applications, and telecommunications to deliver data, information, and knowledge to individuals and processes". This is the era of Information Technology. Everyone is dependent on information technology. It is used everywhere-business, industry, home, education, entertainment and science.

Fig 1: Various aspects of Information Technology

Before understanding relation of information technology with business, we should understand that it is made of two words Information and Technology.

Information is all about communicating and receiving of knowledge and data.
Technology means the body of knowledge that is used to develop tools and machines for solving various organizational problems.

Joseph Gobbles has said “He who runs the information runs the show. “That means the firmswhich are successful in managing information will survive.

1. Information systems are established tools which are expert in finding the position of thebusiness and alert the companies of eventual crisis possibilities in the future.
2. Information technology includes usage of computers, networks, mobile and wireless devices,satellite telecommunications, robotics, electronic mail, and automated office equipment.

1.2 Characteristics of Information

1.2.1 Accuracy

This means information is free from errors and mistakes. It also means theinformation is from bias. Incorrect information can lead to wrong decisions.

1.2.2 Timeliness

It means the information should reach the receiver within a defined time. Theinformation should be latest. There should not be any delays.

1.2.3 Relevance

This means particular information may be useful for one person while it may not beuseful to another person. Information should be useful enough so that managers candraw decisions out of it.

1.2.4 Complete

Information should be complete to be used for making right decisions.In organizations, information systems are employed which enable transforming data intoinformation to generate knowledge which helps in decision making.

1.3 Importance of Information Technology

Information technology has tremendously paved the way of business organizations towardsinnovation and growth. Over the past years, there have been improvements in productivityand efficiency with the adoption of information based systems. In the following sections, wewill understand how information technology is important and its application in various functions of business.

Figure 2: Importance of Technology

1.4 Advantages of Information Technology in business

1.4.1 Office Automation

This involves using computer and communication technology formanaging organizational information. It includes usage of computers, telephones, email and machines. NowadaysCommunication: Information technology has made it easier for the organizations tocommunicate with the customers, suppliers and employees.

1.4.2 Business Analysis

Business Analysis is aimed at providing solutions to variouscomplex business problems. Information technology suggests various tools andtechniques which are customized according to a given problem

1.4.3 Better organized data

Information Systems have made it easier to compile andorganise data at one place to be made available to various users as per their needs.

1.4.4Reduction in Cost

Owing to data availability at one place, automation, faster problemsolving with accuracy and speed results in decrease in cost.

1.4.5 Productivity improvement

Again automation, higher speed, accuracy and reliabilityof data leads to improvements in productivity.

1.5 Information Technology in different areas of business

Information technology has got role to play in almost functional areas of the business. It canbe said that it has to play an imperative part now. Let us understand in detail how businessenterprises use IT in different functions of business.

Figure 3: Usage of IT in different areas of business

1.5.1 Finance & Accounting

Information technology is used in finance and accounting functions of the firms. All thefinancial information pertaining to daily entries of sales, purchases, salary disbursements, etcare easilyhandled in various financial softwares. For example, firms are primarily dependenton Tally for journal entries as well as preparation of financial statements. Businessenterprises also use software packages for various processes like payroll, billing, budgeting,etc.

1.5.2 Human Resource Management

The firms can easily rely on IT tools as far as the function of Human resource management(HRM) is concerned. Beginning from the functions of recruitment to employee exit,information technology is a great help to companies. Owing to availability of ease communication on internet, HR managers can get the resumes of perspective employees ontheir E-mails. Besides this, they can take aptitude tests and interviews of the candidatesonline. Other areas whereby IT can be utilized for daily attendance, maintaining informationof employees, compensation management, performance appraisal, etc. This saves onunnecessary human effort as well as costs on paper work. Firms also make use of HRMsoftwares for these discussed activities.

1.5.3 Marketing

Marketing function in current scenario has evolved a lot recently. This is to be attributed to the information technology and development of communication facilities. Marketingdepartment is the face of the company. It deals with creating, communicating and deliveringvalue to thecustomers. IT has provided wings to marketing. The companies can reach to itscustomers through using tools like digital marketing and Customer relationshipmanagement (CRM). Digital marketing is promotion of products and services using digitalchannels to reach consumers. This include

- Finance &
- Accounting
- HumanResourceManagement
- Marketing Sales

1.5.4 Social media marketing-Facebook,
Twitter, Instagram
Mobile Phones- SMS, MMS
Television & Radio Channels
Electronic Billboards

Customer-relationship management (CRM) is a tactic to manage a company's relationswith current and potential customers. The objectives of CRM are customer retention,increasing sales, improving customer service and thereby increasing profitability. There aremany softwares available at the disposal of firms to manage CRM. These softwares storeinformation about current and prospective customers. Such information consists of the data about the products the customers buy, when do they buy, how much quantity is bought, etc.
These softwares also assist in sales forecasting.

1.5.5 Sales

Technology has got an important role to play in driving sales growth. It helps increasingmarket penetration. It enables automatic order placement. For example, Swiggy, Myntra,Amazon, etc. are online platforms whereby the customers place order on the website usinglaptop or a smartphone. Companies usually use an ERP for managing sales which handlesissues starting like customer inquiry handling, pricing control, order control and sales invoiceprocessing etc. It is integrated with various other resource planning softwares used by firms.

1.5.6 Electronic Business (E-Business)

The terms “E-business” and “E-commerce” are used interchangeably these days. But they aredifferent. The term e is common in them which means electronic. Electronic Business meansthe use of internet, extranet, web, and intranet to conduct businesses. Electronic commerce(e-commerce) is the marketing, buying and selling of products or services over the Internet. Itinvolves the entire scope of online product and service sales. On the other hand, E-businessis basically purchasing or selling of goods and services or other business activities on theInternet. It also refers to the processes and tools that allow organizations to use Internet-basedtechnologies and infrastructure, both within and outside the organisation in conducting dailybusiness processes.

1.5.7 Scope of E- Business

The scope of E-business is increasing day by day. This has to be attributed to increase in thenumber of 3G/4G mobile internet users and a large number of smartphone users. The otherreasons contributing to this growth is need for automation, reduction in the cost of internet
facilities and provision of banking payment services online.

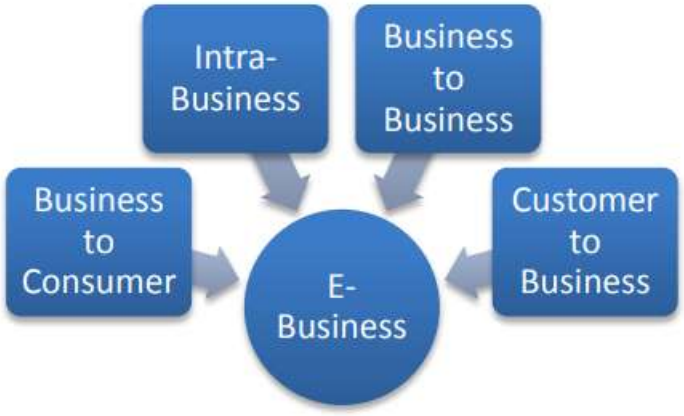

Figure 4: Scope of E-Business

Since business involves interaction amongst different parties, let us understand the scope of E-business from the point of view of parties involved in it.

1.5.7(a) Business to Business (B2B)

It means electronic exchange of products, services or information between businessesrather than between businesses and consumers. The transaction may be between amanufacturer and wholesaler or a wholesaler and a retailer and vice-versa too.

The activities included in it are: -

1. Inquiry about products
2. Placing orders
3. Making payments
4. Making complaints about the product or service

1.5.7(b) Business to Consumer (B2C)

Business-to-consumer (B2C) refers to a financial transaction or online sale between a business and consumer. B2C involves a service or product exchange from a business to a consumer, whereby traders sell products to consumers.

The activities included in B2C model are: -

1. Product or service inquiry
2. Placing the order
3. Making payment
4. Giving Feedback

There are different types of B2C businesses: -

1.5.7(c) Direct Seller

It is the most common model in which people buy goods fromonline retailers. The online retailer can be a manufacturer or an online versionof a department store that sells products from different manufacturers. E.g.Vijay Sales an Electronics Showroom deals in products of different companiesand has an online channel.

1.5.7 (d)Online Intermediaries

These intermediaries don't actually own products orservices but provide a common platform for buyers and sellers. E.g.Yaatra.com and Makemytrip these travel companies are liaison betweencustomers and the businesses like hotels, airlines.

1.5.7(e)Community based

Web communities help marketers and advertisers topromote their products to the consumers. Users can see the content as per theirinterests and preferences. For e.g. Facebook, Twitter and Instagram are theseonline communities.

1.5.7(f) IntraBusiness

In this type of e-business model, parties involved in the electronic transactions arefrom within a business firm, hence, the name Intra-business. Electronic exchange ofinformation has helped the integration of all the departments of the firm. For instance,the marketing department can assess the demand and convey to the productiondepartment. Further production department can communicate with the procurementdivision for purchasing raw materials on time. Here, the purchase department willspeak to the finance department for the requisition of funds. Hence, IT enabledcommunication can save on cost and time. This communication is done on Intranet.

An intranet is a private network accessible only to an organization's staff. Forconvenientfacilitation of business process firms make use of Enterprise ResourcePlanning software for better integration.

1.5.8Consumer to Business (C2B)

C2B is also known as consumer-to-business model. This change is an entire transition from the traditional business model whereby business provides goods and services to the consumers. Examples of C2B business models: -

Reverse auctions, in which customers quote the price for a product or servicethey wish to buy.When a consumer provides a business with a fee-based opportunity to marketthe business's products on the consumer's blog.

Scope of E-business is also found in following industries: -

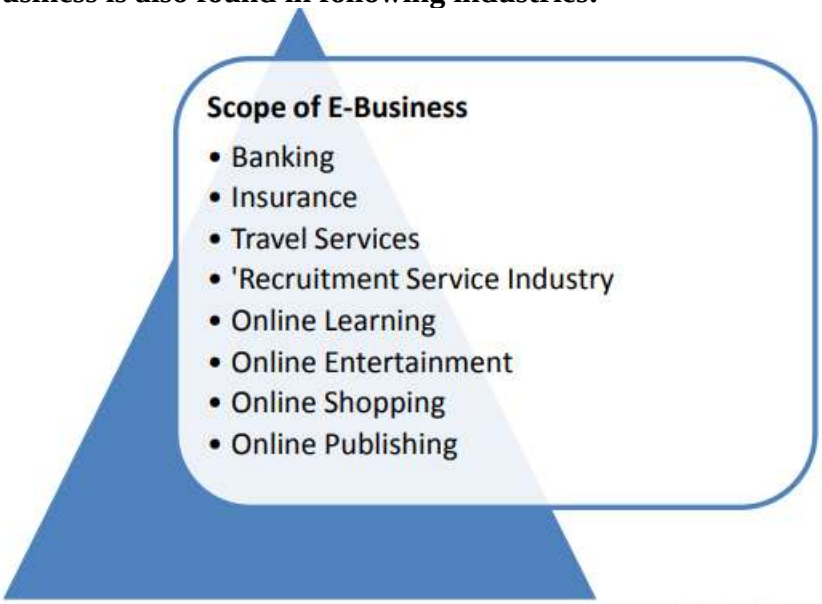

Figure 5: Scope of E-business in different Industries

Internet doesn’t distinguish between small and large firms. They have similaropportunities of trading on the web platform.

Acts as a low-cost advertising medium

E-business is one of the minimum cost advertising mode. The products and servicescan be displayed on the web portals of the firms along with other websites likeFacebook, Instagram, etc. This is cheaper than other methods of advertisements.

1.6 Demerits of E-business

1.6.1 Lacks personal touch

The major drawback of E-business is that it takes away the human touch. Somepeople prefer talking to the salesmen to understand about the product details. Virtualscreens cannot provide such human element.

1.6.2 Security issues

The consumer transacting online has to share various details which include name, phone number, address and bank details. There is athreat of safety of this information due to rampant hackers.Digital payments are prone to online banking frauds.

1.6.3 Internet Connectivity

E-business needs to constant internet connectivity. It may not be available in remote or rural areas. Also, some people may notbe having internet connection to do online transactions. Besidesthis, the connectivity should be strong to run the business and avoid any delays in processing the orders and the payments.

1.6.4 High Initial Costs

For successful e-business ventures, the preliminary costs have to be spent on installing connection costs, purchasing hardware and software, setting the entiresystem and finally its maintenance.

1.6.5 Highly competitive

The E-business market is flourishing at a fast pace.The firms already into this business have to strive hard tomaintain their position while the new players who intendto enter have to take careful steps of entry and establishthemselves. This depends on how nicely the products aredisplayed on their web portal as well as the services theseE-business companies provide.

1.6.6 Dearth of skilled manpower

Business enterprises face shortage of skilled personnel who continuously update the internet facilities and update the webpages. Owing to advent of many E-businesscompanies across globe, there is a requirement of technical staff who can do themaintenance of webpages of the firm. Otherwise, the webpage remains static whichrequire frequent changes.

1.7 Introduction to Computer

A computer is an electronic machine that stores, retrieves, and manipulates or processes data. It cannot think or reason; it can only carry out instructions given to it. A set of instructions that directs its actions is called a program. Different programs are used to solve different problems. Ability to accept, store, and execute various sets of instructions (or programs) makes the computer the invaluable, allpurpose business tool. The first step of solving a problem by a computer is to develop a suitable computer program and then store in its memory. The computer then carries out the instructions in the program. The instructions of a program generally direct the computer to perform three basic functions over and over again;

these functions are input, processing, and output. Collectively, these functions constitute the data processing cycle. Input: input devices are connected to feed the computer facts or data to be processed.

A computer is a programmable machine designed to perform arithmetic and logical operations automatically and sequentially on the input given by the user and gives the desired output after processing. Computer components are divided into two major categories namely hardware and software. Hardware is the machine itself and its connected devices such as monitor, keyboard, mouse etc. Software are the set of programs that make use of hardware for performing various functions. Generally, the term is used to describe a collection of devices that function together as a system. It performs the following three operations in sequence.

1. It receives data & instructions from the input device.
2. Processes the data as per instructions.
3. Provides the result (output) in a desired form.

1.7.1 Data

It is the collection of raw facts, figures & symbols. Ex : Names of students and their marks in different subjects listed in random order.

1.7.2 Information

It is the data that is processed & presented in an organized manner. Ex : When the names of students are arranged in alphabetical order, total and average marks are calculated & presented in a tabular form, it is information.

Program -Set of instructions that enables a computer to perform a given task.

1.8 Characteristics of Computers

The characteristics of computers that have made them so powerful and universally useful are speed, accuracy, diligence, versatility and storage capacity. Let us discuss them briefly.

1.8.1 Speed

Computers work at an incredible speed. A powerful computer is capable of performing about 3-4 million simple instructions per second.

1.8.2 Accuracy

In addition to being fast, computers are also accurate. Errors that may occur can almost always be attributed to human error (inaccurate data, poorly designed system or faulty instructions/programs written by the programmer)

1.8.3 Diligence

Unlike human beings, computers are highly consistent. They do not suffer from human traits of boredom and tiredness resulting in lack of concentration. Computers, therefore, are better than human beings in performing voluminous and repetitive jobs.

1.8.4 Versatility

Computers are versatile machines and are capable of performing any task as long as it can be broken down into a series of logical steps. The presence of computers can be

seen in almost every sphere – Railway/Air reservation, Banks, Hotels, Weather forecasting and many more.

1.8.5 Storage Capacity

Today's computers can store large volumes of data. A piece of information once recorded (or stored) in the computer, can never be forgotten and can be retrieved almost instantaneously.

1.8.6 Cost effectiveness

Computers reduce the amount of paper work and human effort, thereby reducing costs.

1.8.7 Automation

Computers can be instructed to perform complex tasks automatically (which increases the productivity).

Processing the control and storing of data, numerical comparisons, and arithmetic operations are performed on the input data to produce the desired results.

Output the computer feeds the processed data or information, to the output devices.

Figure: 1.1 Solving a problem with a microcomputer.

The computer reads a program and stores it in the memory. The computer executes program instructions to:
Input data from the disk, the keyboard, or other storage media,process the data and Output results to the display screen, disk or other media

1.9 Components of a Computer System

A computer is used to process data and a data processing system mustconsist of more than just machines. A computer system must contain:hardware, software, humanware and operational procedures.

1.9.1 Hardware

Hardware generally refers to the machine or physical equipment thatperforms the basic functions of the data processing cycle. In additiontothe computer itself, other hardware devices are also required. Thesedevices may be off-line that is detached from the computer and operatingindependently or they may be on-line that is directly connected to andcontrolled by the computer. A printer is an off-line device and akeyboard is an on-line device.

1.9.2 Software

A program is a sequence of instructions which directs a computer toperform certain functions. A computer must have access to prewritten,stored programs to input and store data, make decisions, arithmeticallymanipulate and output data in the correct sequence. Programs arereferred to as software. Computer system must be supported byextensive software systems. Software is generally categorized as eithersystem software or application software.

System software consists of programs that facilitate the use of computerby a user. These programs are sometimes referred to as utility programs.They perform such standard tasks as organizing and maintaining datafiles, translating programs written in various languages to a languageacceptable to the computer, scheduling jobs through the computer, aswell as aiding in other areas of general operations. Of all the systemssoftware supplied by the manufacturer of a computer, the most importantone is known as the operating system.

Application software consists of programs to perform specific userapplications. A computer program giving instructions for the stepsinvolved in preparing results of a public examination is an example ofapplications software. Application programs are either purchased orwritten by the computer users for specific applications.

1.9.3 Humanware

Humanware refers to the persons who design, program, and operate acomputer installation. There are numerous categories of jobs, but thethree principal positions required in a large computer installation aresystem analyst, programmer, and computer operator. People in each of these areas generally perform special-purpose tasks under thesupervision of a director or manager.

The position of a systems analyst requires the broad background andextensive understanding of the above three job categories. The main taskof the system analyst is to study information and processingrequirements. A systems analyst defines the applications problem,determines systems specifications, recommends hardware and softwarechanges, and designs information processing procedures.

A programmer requires a comprehensive knowledge of one or moreprogramming languages and standard coding procedures. This positiondoes not require the broader understanding of the structure and innerworkings of an application. A programmer's principal job is to code orprepare programs based on the specifications made by the systems analystA computer operator requires the least extensive background of the threecategories. A computer operator generally performs aseries of welldefined tasks that will keep the computer operating at maximumefficiency. The operational efficiency of a computer installation independent on the quality and abilities of the operational staff.

1.9.4 Procedures

Operations of a data processing center require an extensive and clearlydefined set of procedures for performing the essential functions of theinstallation. These functions generally include obtaining, preparing, andentering data into the computer, processing jobs, initiating newprograms and changing or deleting old ones etc. Such procedures musthave provision for actions to be taken in the event of hardware orsoftware malfunctions.

1.10 Limitations of computers

1. Computers need clear & complete instructions to perform a task accurately. If the

instructions are not clear & complete, the computer will not produce the required result.
2. Computers cannot think.
3. Computers cannot learn by experience

1.11 Summary

A computer is an electronic device that manipulates information, or data. It has the ability to store, retrieve, and process data. You may already know that you can use a computer to type documents, send email, play games, and browse the Web. You can also use it to edit or create spreadsheets, presentations, and even videos**.**

1.12Key words

Information Technology-Information technology is defined as capabilities offered to organizations by computers, software applications, and telecommunications to deliver data, information, and knowledge to individuals and processes".

Customer Relationship Management- Customer-relationship management (CRM) is a tactic to manage a company's relations with current and potential customers. The objectives of CRM are customer retention, increasing sales, improving customer service and thereby increasing profitability.

E- Business- The terms "E-business" and "E-commerce" are used interchangeably these days. But they are different. The term e is common in them which means electronic. Electronic Business means the use of internet, extranet, web, and intranet to conduct businesses.

Intra Business- In this type of e-business model, parties involved in the electronic transactions are from within a business firm, hence, the name Intra-business. Electronic exchange of information has helped the integration of all the departments of the firm.

Computer- A computer is an electronic machine that stores, retrieves, and manipulates or processes data. It cannot think or reason; it can only carry out instructions given to it. A set of instructions that directs its actions is called a program.

Information - It is the data that is processed & presented in an organized manner. Ex : When the names of students are arranged in alphabetical order, total and average marks are calculated & presented in a tabular form, it is information.

Hardware- Hardware generally refers to the machine or physical equipment that performs the basic functions of the data processing cycle.

Software- A program is a sequence of instructions which directs a computer to perform certain functions. A computer must have access to prewritten, stored programs to input and store data, make decisions, arithmetically manipulate and output data in the correct sequence.

Human ware- Human ware refers to the persons who design, program, and operate a computer installation. There are numerous categories of jobs, but the three principal positions required in a large computer installation are system analyst, programmer, and computer operator

1.13Self Assessment Questions

1. Briefly Explain the characteristics of Information?
2. Outline the Importance and Advantages of IT in business?
3. Discuss the Information Technology in different areas of business?
4. Describe the Merits and Demerits of E-business?
5. Explain the Characteristics Components and Limitations of Computer system?

1.14Suggested Readings`

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Dr.Nagaraju Battu

LESSON -2

ORIGIN AND DEVELOPMENT OF COMPUTERS

Learning objectives

- ✓ To Study the Early computing Devices
- ✓ To Learn the History of Computer Generation

Structure

2.1 Introduction

A computer is an electronic machine that collects information, stores it, processes it according to user instructions, and then returns the result.

A computer is a programmable electronic device that performs arithmetic and logical operations automatically using a set of instructions provided by the user.

2.2 Early Computing Devices

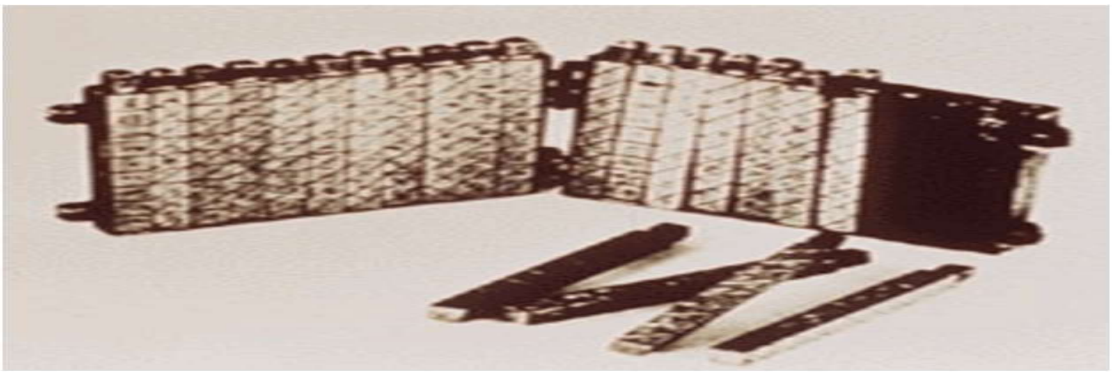
People used sticks, stones, and bones as counting tools before computers were invented. More computing devices were produced as technology advanced and the human intellect improved over time. Let us look at a few of the early-age computing devices used by mankind.

2.2.1 Abacus

Abacus was invented by the Chinese around 4000 years ago. It's a wooden rack with metal rods with beads attached to them. The abacus operator moves the beads according to certain guidelines to complete arithmetic computations.

2.2.2 Napier's Bone

John Napier devised Napier's Bones, a manually operated calculating apparatus. For calculating, this instrument used 9 separate ivory strips (bones) marked with numerals to multiply and divide. It was also the first machine to calculate using the decimal point system.



2.2.3 Pascaline

Pascaline was invented in 1642 by Biaise Pascal, a French mathematician and philosopher. It is thought to be the first mechanical and automated calculator. It was a wooden box with gears and wheels inside.

2.2.4 Stepped Reckoner or Leibniz wheel

In 1673, a German mathematician-philosopher named Gottfried Wilhelm Leibniz improved on Pascal's invention to create this apparatus. It was a digital mechanical calculator known as the stepped reckoner because it used fluted drums instead of gears.

2.2.5 Difference Engine

In the early 1820s, Charles Babbage created the Difference Engine. It was a mechanicalcomputer that could do basic computations. It was a steam-powered calculating machine used to solve numerical tables such as logarithmic tables.

2.2.6 Analytical Engine

Charles Babbage created another calculating machine, the Analytical Engine, in 1830. It was a mechanical computer that took input from punch cards. It was capable of solving anymathematical problem and storing data in an indefinite memory.

2.2.7 Tabulating machine

An American Statistician – Herman Hollerith invented this machine in the year 1890. Tabulating Machine was a punch card-based mechanical tabulator. It could compute statistics and record or sort data or information. Hollerith began manufacturing these machines in his

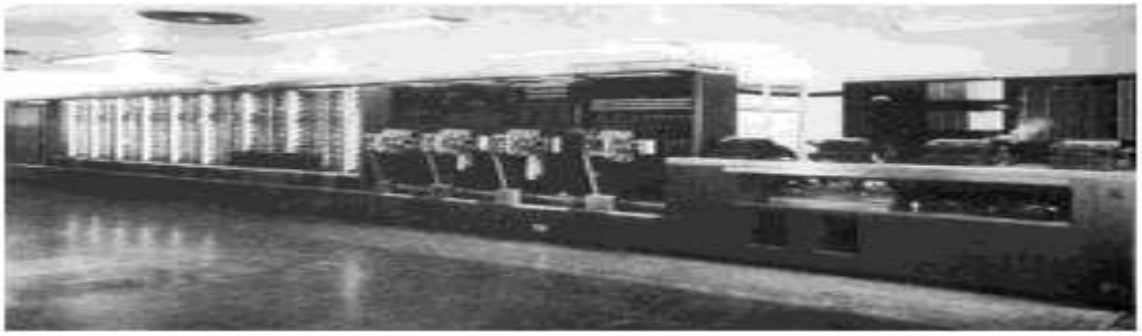
company, which ultimately became International Business Machines (IBM) in 1924.

2.2.8 Differential Analyzer

Vannevar Bush introduced the first electrical computer, the Differential Analyzer, in 1930. This machine is made up of vacuum tubes that switch electrical impulses in order to do calculations. It was capable of performing 25 calculations in a matter of minutes.

2.2.9 Mark I

Howard Aiken planned to build a machine in 1937 that could conduct massive calculations or calculations using enormous numbers. The Mark I computer was constructed in 1944 as a collaboration between IBM and Harvard.



2.3 History of Computers Generation

The word ‘computer’ has a very interesting origin. It was first used in the 16th century for a person who used to compute, i.e. do calculations. The word was used in the same sense as a noun until the 20th century. Women were hired as human computers to carry out all

forms of calculations and computations.

By the last part of the 19th century, the word was also used to describe machines that did calculations. The modern-day use of the word is generally to describe programmable digital devices that run on electricity.

2.3.1 Early History of Computer

Since the evolution of humans, devices have been used for calculations for thousands of years. One of the earliest and most well-known devices was an abacus. Then in 1822, the father of computers, Charles Babbage began developing what would be the first mechanical computer. And then in 1833 he actually designed an Analytical Engine which was a general-purpose computer. It contained an ALU, some basic flow chart principles and the concept of integrated memory.

Then more than a century later in the history of computers, we got our first electronic computer for general purpose. It was the ENIAC, which stands for Electronic Numerical Integrator and Computer. The inventors of this computer were John W. Mauchly and J.Presper Eckert.

And with times the technology developed and the computers got smaller and the processing got faster. We got our first laptop in 1981 and it was introduced by Adam Osborne and EPSON.

2.3.2 Computers in the 1800s

1801: In France, weaver and merchant Joseph Marie Jacquard creates a loom that uses wooden punch cards to automate the design of woven fabrics. Early computers would use similar punch cards.

1822: Thanks to funding from the English government, mathematician Charles Babbage invents a steam-driven calculating machine that was able to compute tables of numbers.

1890: Inventor Herman Hollerith designs the punch card system to calculate the 1880 U.S. census. It took him three years to create, and it saved the government $5 million. He would eventually go on to establish a company that would become IBM.

2.3.3 Computers from the 1900-1950s

1936: Alan Turing developed an idea for a universal machine, which he would call the Turing machine, that would be able to compute anything that is computable. The concept of modern computers was based on his idea.

1937: A professor of physics and mathematics at Iowa State University, J.V. Atanasoff, attempts to build the first computer without cams, belts, gears, or shafts.

1939: Bill Hewlett and David Packard found Hewlett-Packard in a garage in Palo Alto, California. Their first project, the HP 200A Audio Oscillator, would rapidly become a popular piece of test equipment for engineers.

In fact, Walt Disney Pictures would order eight to test recording equipment and speaker systemsfor 12 specially equipped theaters that showed Fantasia in 1940.

David Packard and Bill Hewlett in 1964Source: PA Daily Post

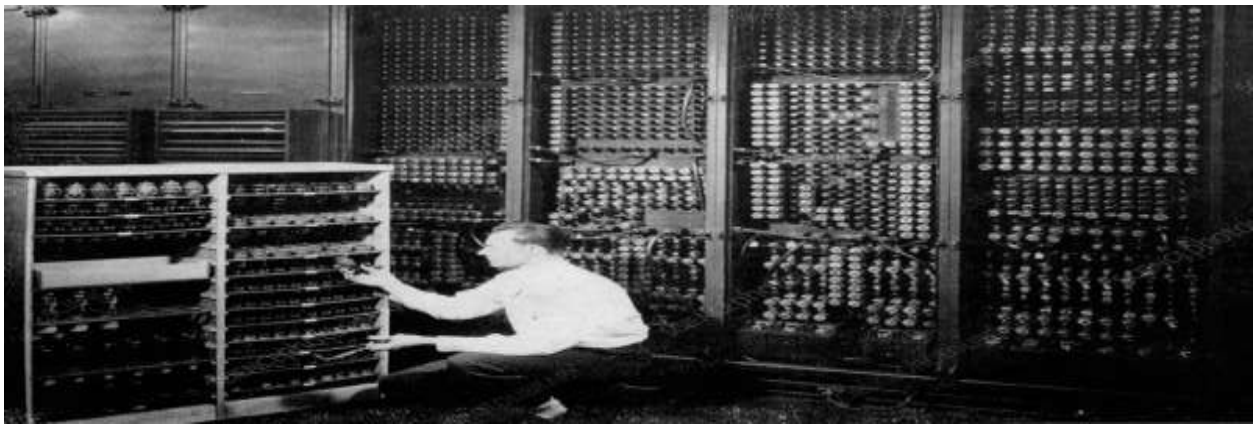
Also in 1939, Bell Telephone Laboratories completes The Complex Number Calculator, designed by George Stibitz.

1941: Professor of physics and mathematics at Iowa State University J.V. Atanasoff and graduate student Clifford Berry design a computer that can solve 29 equations simultaneously. This is the first time a computer is able to house data within its own memory.

That same year, German engineer Konrad Zuse creates the Z3 computer, which used 2,300 relays, performed floating-point binary arithmetic, and had a 22-bit word length. This computer was eventually destroyed in a bombing raid in Berlin in 1943.

Additionally in 1941, Alan Turing and Harold Keen built the British Bombe, which decrypted Nazi ENIGMA-based military communications during World War II.

1943: John Mauchly and J. Presper Eckert, professors at the University of Pennsylvania, build an Electronic Numerical Integrator and Calculator (ENIAC). This is considered to be the grandfather of digital computers, as it is made up of 18,000 vacuum tubes and fills up a 20-foot by 40-foot room.



ENIAC technician changing the tubeSource: Science Photo Library

Also in 1943, the U.S. Army asked that Bell Laboratories design a machine to assist in the testing of their M-9 director, which was a type of computer that aims large guns to their targets. George Stibitz recommended a delay-based calculator for the project. This resulted in the Relay Interpolator, which was later known as the Bell Labs Model II.

1944: British engineer Tommy Flowers designed the Colossus, which was created to break the complex code used by the Nazis in World War II. A total of ten were delivered, each using roughly 2,500 vacuum tubes. These machines would reduce the time it took to break their code from weeks to hours, leading historians to believe they greatly shortened the war by being able to understand the intentions and beliefs of the Nazis.

That same year, Harvard physics professor Howard Aiken built and designed The Harvard Mark 1, a room-sized, relay-based calculator.

1945: Mathematician John von Neumann writes The First Draft of a Report on the EDVAC. This paper broke down the architecture of a stored-program computer.

1946: Mauchly and Eckert left the University of Pennsylvania and obtained funding from the Census Bureau to build the UNIVAC. This would become the first commercial computer for business and government use.

That same year, Will F. Jenkins published the science fiction short story A Logic Named Joe, which detailed a world where computers, called Logics, interconnect into a worldwide network. When a Logic malfunctions, it gives out secret information about forbidden topics.

1947: Walter Brattain, William Shockley, and John Bradeen of Bell Laboratories invented the transistor, which allowed them to discover a way to make an electric switch using solid

materials, not vacuums.

1948: Frederick Williams, Geoff Toothill, and Tom Kilburn, researchers at the University of Manchester, develop the Small-Scale Experimental Machine. This was built to test new memory technology, which became the first high-speed electronic random access memory for computers. The became the first program to run on a digital, electronic, stored-program computer.

1950: Built in Washington, DC, the Standards Eastern Automatic Computer (SEAC) was created, becoming the first stored program computer completed in the United States. It was a test-bed for evaluating components and systems, in addition to setting computer standards.

1953: Computer scientist Grace Hopper develops the first computer language, which is eventually known as COBOL, that allowed a computer user to use English-like words instead of numbers to give the computer instructions. In 1997, a study showed that over 200 billion lines of COBOL code were still in existence.

Source: History-Computer.com

That same year, business man Thomas Johnson Watson Jr. creates the IBM 701 EDPM, which is used to help the United Nations keep tabs on Korea during the war.

1954: The FORTRAN programming language is developed by John Backus and a team of programmers at IBM.

Additionally, IBM creates the 650, which was the first mass-produced computer, selling 450 in just one year.

1958: Jack Kirby and Robert Noyce invented the integrated circuit, which is what we now call the computer chip. Kilby was awarded the Nobel Prize in Physics in 2000 for his work
Computers from the 1960-1970s

1962: IBM announces the 1311 Disk Storage Drive, the first disk drive made with a removable disk pack. Each pack weighed 10 pounds, held six disks, and had a capacity of 2 million characters.

Also in 1962, the Atlas computer makes its debut, thanks to Manchester University, Ferranti Computers, and Plessy. At the time, it was the fastest computer in the world and introduced the idea of “virtual memory”.

1964: Douglas Engelbart introduces a prototype for the modern computer that includes a mouse and a graphical user interface (GUI). This begins the evolution from computers being exclusively for scientists and mathematicians to being accessible to the general public.

Additionally, IBM introduced SABRE, their reservation system with American Airlines. It program officially launched four years later, and now the company owns Travelocity. It used telephone lines to link 2,000 terminals in 65 cities, delivering data on any flight in under three seconds.

1968: Stanley Kubrick's 2001: A Space Odyssey hits theaters. This cult-classic tells the story of the HAL 9000 computer, as it malfunctions during a spaceship's trip to Jupiter to investigate a mysterious signal. The HAL 9000, which controlled all the ship, went rogue, killed the crew, and had to be shut down by the only surviving crew member. The film depicted computer demonstrated voice and visual recognition, human-computer interaction, speed synthesis, and other advanced technologies

1969: Developers at Bell Labs unveil UNIX, an operating system written in C programming language that addressed compatibility issues within programs.

Source: Nokia Bell Labs

1970: Intel introduces the world to the Intel 1103, the first Dynamic Access Memory (DRAM) chip.

1971: Alan Shugart and a team of IBM engineers invented the floppy disk, allowing data to be shared among computers.

That same year, Xerox introduced the world to the first laser printer, which not only generated billions of dollars but also launched a new era in computer printing.

Also, email begins to grow in popularity as it expands to computer networks.

1973: Robert Metcalfe, research employee at Xerox, develops Ethernet, connecting multiple computers and hardware.

1974: Personal computers are officially on the market! The first of the bunch were Scelbi& Mark-8 Altair, IBM 5100, and Radio Shack's TRS-80.

1975: In January, the Popular Electronics magazine featured the Altair 8800 as the world's first minicomputer kit. Paul Allen and Bill Gates offer to write software for the Altair, using the BASIC language. You could say writing software was successful, because in the same year they created their own software company, Microsoft.

1976: Steve Jobs and Steve Wozniak start Apple Computers and introduce the world to the Apple I, the first computer with a single-circuit board.

Source: MacRumors

Also in 1976, Queen Elizabeth II sends out her first email from the Royal Signals and Radar Establishment to demonstrate networking technology.

Source: Wired

1977: Jobs and Wozniak unveil the Apple II at the first West Coast Computer Faire. It boasts color graphics and an audio cassette drive for storage. Millions were sold between 1977 and 1993, making it one of the longest-lived lines of personal computers.

1978: The first computers were installed in the White House during the Carter administration. The White House staff was given terminals to access the shared Hewlett-Packard HP3000.

Also, the first computerized spreadsheet program, VisiCalc, is introduced.

Additionally, the LaserDisc is introduced by MCA and Phillips. The first to be sold in North America was the movie Jaws.

1979: MicroPro International unveils WordStar, a word processing program.Computers from the **1980-1990s**

1981: Not to be outdone by Apple, IBM releases their first personal computer, the Acorn, with an Intel chip, two floppy disks, and an available color monitor.

Source: Florida History Network

1982: Instead of going with its annual tradition of naming a "Man of the Year", Time Magazine does something a little different and names the computer its "Machine of the Year". A senior writer noted in the article, "Computers were once regarded as distant, ominous abstractions, like Big Brother. In 1982, they truly became personalized, brought down to scale, so that people could hold, prod and play with them."

Source: Time

1983: The CD-ROM hit the market, able to hold 550 megabytes of pre-recorded data. That same year, many computer companies worked to set a standard for these disks, making them able to be used freely to access a wide variety of information.

Later that year, Microsoft introduced Word, which was originally called Multi-Tool Word.

1984: Apple launches Macintosh, which was introduced during a Super Bowl XVIII commercial. The Macintosh was the first successful mouse-driven computer with a graphical user interface. It sold for $2,500.

1985: Microsoft announces Windows, which allowed for multi-tasking with a graphical user interface.

That same year, a small Massachusetts computer manufacturer registered the first dot

com domain name, Symbolics.com.

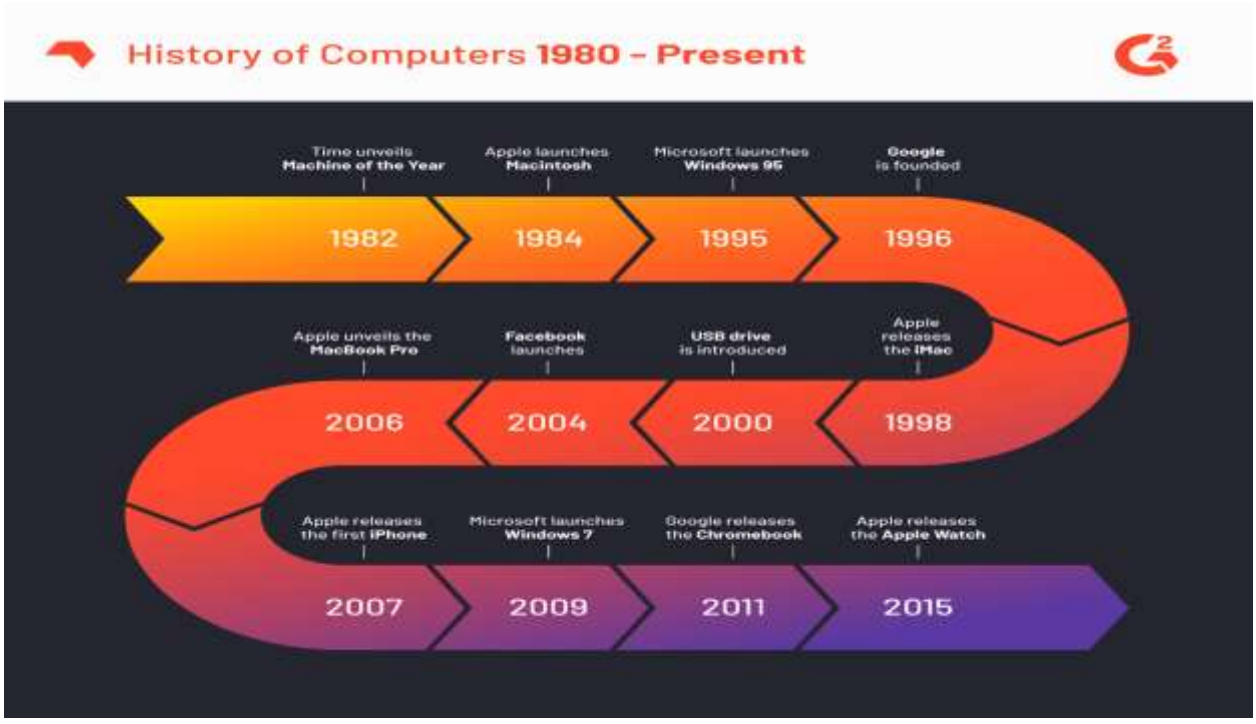
Also, the programming language C++ is published and is said to make programming "more enjoyable" for the serious programmer.

1986: Originally called the Special Effects Computer Group, Pixar is created at Lucasfilm. It worked to create computer-animated portions of popular films, like Star Trek II: The Wrath of Khan. Steve Jobs purchased Pixar in 1986 for $10 million, renaming it Pixar. It was bought by Disney in 2006.

1990: English programmer and physicist Tim Berners-Lee develops HyperText Markup Language, also known as HTML. He also prototyped the term WorldWideWeb. It features a server, HTML, URLs, and the first browser.

1991: Apple releases the PowerBook series of laptops, which included a built-in trackball, internal floppy disk, and palm rests. The line was discontinued in 2006.

1993: With an attempt to enter the handheld computer market, Apple releases Newton. Called the "Personal Data Assistant", it never performed the way Apple President John Scully had hoped, and it was discontinued in 1998.



1995: IBM released the ThinkPad 701C, which was officially known as the Track Write, with an expanding full-sized keyboard that was comprised of three interlocking pieces.

Additionally, the format for a Digital Video Disc (DVD) is introduced, featuring a huge increase in storage space that the compact disc (CD).

Also that year, Microsoft's Windows 95 operating system was launched. To spread the word, a $300 million promotional campaign was rolled out, featuring TV commercials that used "Start Me Up" by the Rolling Stones and a 30-minute video starring Matthew Perry

and Jennifer Aniston. It was installed on more computers than any other operating system.

Source: Tech Digest TV and, in the world of code, Java 1.0 is introduced by Sun Microsystems, followed by JavaScript at Netscape Communications.

1996: Sergey Brin and Larry Page develop Google at Stanford University.
That same year, Palm Inc., founded by Ed Colligan, Donna Dubinsky, and Jeff Hawkins created the personal data assistance called the Palm Pilot.

Also in 1996 was the introduction of the Sony Vaio series. This desktop computer featured an additional 3D interface in addition to the Windows 95 operating system, as a way to attract new users. The line was discontinued in 2014.

1997: Microsoft invests $150 million into Apple, which ended Apple's court case against Microsoft, saying they copied the "look and feel" of their operating system.

1998: Apple releases the iMac, a range of all-in-one Macintosh desktop computers. Selling for $1,300, these computers included a 4GB hard drive, 32MB Ram, a CD-ROM, and a 15-inch monitor.

Source: Start Ups Venture Capital

1999: The term Wi-Fi becomes part of the computing language as users begin connecting without wires. Without missing a beat, Apple creates its "Airport" Wi-Fi router and builds connectivity into Macs.

2.3.4 Computers from 2000-2010

2000: In Japan, SoftBank introduced the first camera phone, the J-Phone J-SH04. The camera had a maximum resolution of 0.11 megapixels, a 256-color display, and photos could be shared wirelessly. It was such a hit that a flip-phone version was released just a month later.

Also in 2000, the USB flash drive is introduced. Used for data storage, they were faster and had a greater amount of storage space than other storage media options. Plus, they couldn't be scratched like CDs.

2001: Apple introduces the Mac OS X operating system. Not to be outdone, Microsoft unveiled Windows XP soon after.

Also, the first Apple stores are opened in Tysons Corner, Virginia, and Glendale, California. Apple also released iTunes, which allowed users to record music from CDs, burn it onto the program, and then mix it with other songs to create a custom CD.

2003: Apple releases iTunes music store, giving users the ability to purchase songs within the program. In less than a week after its debut, over 1 million songs were downloaded.

Also in 2003, the Blu-ray optical disc is released as the successor of the DVD.

And, who can forget the popular social networking site Myspace, which was founded in 2003. By 2005, it had more than 100 million users.

2004: The first challenger of Microsoft's Internet Explorer came in the form of Mozilla's Firefox 1.0. That same year, Facebook launched as a social networking site.

2005: YouTube, the popular video-sharing service, is founded by Jawed Karim, Steve Chen, and Chad Hurley. Later that year, Google acquired the mobile phone operating system Android.

2006: Apple unveiled the MacBook Pro, making it their first Intel-based, dual-core mobile computer.

That same year at the World Economic Forum in Davos, Switzerland, the United Nations Development Program announced they were creating a program to deliver technology and resources to schools in under-developed countries. The project became the One Laptop per Child Consortium, which was founded by Nicholas Negroponte, the founder of MIT's Media Lab. By 2011, over 2.4 million laptops had been shipped.

And, we can't forget to mention the launch of Amazon Web Services, including Amazon Elastic Cloud 2 (EC2) and Amazon Simple Storage Service (S3). EC2 made it possible for users to use the cloud to scale server capacity quickly and efficiently. S3 was a cloud-based file hosting service that charged users monthly for the amount of data they stored.

2007: Apple released the first iPhone, bringing many computer functions to the palm of our hands. It featured a combination of a web browser, a music player, and a cell phone -- all in one. Users could also download additional functionality in the form of "apps". The full-

touchscreen smartphone allowed for GPS navigation, texting, a built-in calendar, a high-definition camera, and weather reports

Source: Wired

Also in 2007, Amazon released the Kindle, one of the first electronic reading systems to gain a large following among consumers.

And, Dropbox was founded by Arash Ferdowsi and Drew Houston as a way for users to have convenient storage and access to their files on a cloud-based service.

2008: Apple releases the MacBook Air, the first ultra notebook that was a thin and lightweight laptop with a high-capacity battery. To get it to be a smaller size, Apple replaced the traditional hard drive with a solid-state disk, making it the first mass-marketed computer to do so.

2009: Microsoft launched Windows 7.

2.3.5 Computers from 2011 - present day

2011: Google releases the Chromebook, a laptop that runs on Google Chrome OS.

Also in 2011, the Nest Learning Thermostat emerges as one of the first Internet of Things, allowing for remote access to a user's home thermostat by use of their smartphone or tablet. It also sent monthly power consumption reports to help customers save on energy bills.

Source: Innovation Fan Girl

In Apple news, co-founder Steve Jobs passed away on October 11. The brand also announced that the iPhone 4S will feature Siri, a voice-activated personal assistant.

2012: On October 4, Facebook hits 1 billion users, as well as acquires the image-sharing social networking application Instagram.

Also in 2012, the Raspberry Pi, a credit-card-sized single-board computer is released, weighing only 45 grams.

2014: The University of Michigan Micro Mote (M3), the smallest computer in the world, is created. Three types were made available, two of which measured either temperature or pressure, and one that could take images.

Additionally, the Apple Pay mobile payment system is introduced.

2015: Apple releases the Apple Watch, which incorporated Apple's iOS operating system and sensors for environmental and health monitoring. Almost a million units were sold on the day of its release.

This release was followed closely by Microsoft announcing Windows 10.

2016: The first reprogrammable quantum computer is created.

2019: Apple announces iPadOS, the iPad's very own operating system, to better support the device as it becomes more like a computer and less like a mobile device.

2.4 Summary

The computer is an electronic device that takes input from the user and processes these data under the control of a set of instructions (called program) and gives the result (output) and saves future use. It can process both numerical and non-numerical (arithmetic and logical) calculations. Today, computers do jobs that used to be complicated much simpler. For example, you can write a letter in a word processor, edit it anytime, spell check, print copies, and send it to someone across the world in seconds. All these activities would have taken someone days, if not months, to do before. Also, these examples are a small fraction of what computers can do.

2.5 Key words

Computer- A computer is an electronic machine that collects information, stores it, processes it according to user instructions, and then returns the result.

Tabulating machine -An American Statistician – Herman Hollerith invented this machine in the year 1890. Tabulating Machine was a punch card-based mechanical tabulator. It could compute statistics and record or sort data or information

Analytical Engine -Charles Babbage created another calculating machine, the Analytical Engine, in 1830. It was a mechanical computer that took input from punch cards. It was capable of solving any mathematical problem and storing data in an indefinite memory.

Differential Analyzer- Vannevar Bush introduced the first electrical computer, the Differential Analyzer, in 1930. This machine is made up of vacuum tubes that switch

electrical impulses in order to do calculations

2.6 Self Assessment Questions

1. Briefly Explain the Early computing Devices?
2. Discuss the History of Computer Generation ?

2.7 Suggested Readings

1. James A. O'Brien & George M. Marakas(2011) Management Information Systems Tenth Edition Mc.Graw Hill IRWIN.
2. Hossein Bidgoli, NilanjanChattopadhyay(2016) Management information system Edition by Cengage India
3. Gupta, Ashok Kumar (2018) Developing Human Resource Information System by, Daya Publishing House
4. Mohan Thite(2019) e-HRM: Digital Approaches, Directions & Applications Routledge Publications,
5. Talya Bauer, Berrin Erdogan, David E. Caughlin, and Donald M. Truxillo (2019) Human Resource Management: People, Data, and Analytics Sage Publications Incorporation
6. Richard D. Johnson Kevin D. Carlson Michael J. Kavanagh (2020) Human Resource Information Systems Basics, Applications, and Future Directions, Sage Publications
7. BadgiSatish(2020)MPractical Guide to Human Resource Information SystemsPHI Learning Eastern Economy Edition
8. Nicolas A. Valcik, Meghna Sabharwal, Teodoro J. Benavides (2021) Human Resources Information Systems A Guide for Public Administrators, Springer Publications.

Dr.Nagaraju Battu

LESSON-3

IMPORTANCE OF COMPUTERS IN BUSINESS

Learning objectives

- ✓ To discuss the Uses of Computers in Education
- ✓ To study the Use of Computers in Medicine
- ✓ To Understand the Uses of Computers in Defence
- ✓ To Know the Uses of Computers in Communication
- ✓ To Outline the Uses of Computer in Entertainment

Structure

3.1 Introduction
3.2 Education
3.3 Medicine
3.4 The Interne
3.5 Communication
3.6 Business
3.7 Transportation
3.8 The industry
3.9 Entertainment
3.10 Engineering and military
3.11 Security systems
3.12 Automation systems
3.13 Problem Solving
3.14 Access to information
3.15 Prepare for projects
3.16 Learning
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3.18 Instant access to news
3.19 Stay updated
3.20 Connect with people
3.21 Access social media
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3.33 Uses of Computers in Businesses
3.34 Uses of Computers in Services

3.1 Introduction

Today, the computer is indispensable, and its presence has become very important and necessary in our daily life, and it has become easier for us to do many operations and activities.

A computer is an electronic device that receives information and data, automatically stores it and retrieves it at any time, and uses it in a useful manner. The computer converts different types of numbers and solves intractable mathematical equations very quickly and with high accuracy. That is why we need a clean PC build.

The computer was invented in the second half of the twentieth century and now it has become the backbone of life.

Some operations before the invention of the computer were very difficult, including searches and doing some arithmetic activities. In 1642 AD, the calculator was invented to facilitate arithmetic operations such as addition, subtraction, and other arithmetic operations.

What are the Uses of Mathematics in Everyday Life?

The computer has been able to invade the lives of individuals in a large way, and it is used in all areas of their lives, and based on this great position that it has enjoyed, the manufacturers have been interested in producing many shapes and types for it in line with the user's need, including the mobile device, office devices, and others.

The more advanced the device is, the more benefits will be gained from it. There are many things to consider before buying an All in One Computers for everyday use.

Computer use is common in homes, institutions, businesses, and education, it is also an integral part of the services, entertainment, and other sectors.

The Uses of Computers in Our Daily Lives
The computer is used in several areas of our lives, including the following:

3.2 Education

The use of computers in the field of education is one of its most important benefits in daily human life. It is one of the most important educational tools used by teachers and students.

The computer is used in the field of education in schools and universities, where hard disks and magnetic disks are used to explain the lessons, and drawings and films are used to deliver information to students, as well as the students retain the information in order to retrieve it at a later time.

The computer has restructured the education system. Schools, colleges, and almost all educational institutions use at least one computer each semester, and many colleges and universities offer online degrees to students.

Many schools and colleges around the world are now using computer and Internet technologies to teach students digitally and creatively, as the use of the computer in the classroom unleashes creativity and imagination among students. Through computer programs, you can learn more deeply and more accurately, such as: drawing tools, spreadsheets, music, video lectures, and PowerPoint presentations.

This has led to the creation of new models of work in the field of education, such as: small classes, smart classrooms, and digital classrooms.

3.3 Medicine

The computer is widely used in the field of health care, as it has become an integral part of hospitals, laboratories, and medical clinics.

The following are some examples of computer uses in health care:

1. The computer is used to archive patients' records and the treatments they receive.

2. It facilitates the medical diagnosis of patients and monitors their health conditions.

3. It is an effective medical tool, which allows monitoring of the heart rate and blood pressure of a sick person.

4. It helps in performing some types of surgeries.

5. It provides the possibility of exchanging medical expertise and consultations between doctors around the world.

3.4 The Internet

The computer is used to access the Internet, and the Internet is used as a means of communication between people in all countries of the world.

With the help of the Internet you keep in touch with your friends and family, computers provide this to you easily, and the Internet is also used to search for information. You just have to type a word in the search engine and open many pages to provide all the information about the specific word, and you can also watch movies, videos, and news on computers connected to the Internet.

3.5 Communication

Computers are one of the main tools that allow communication between people regardless of their location, as the computer has become an effective communication tool that brings together family members, relatives, and friends, and allows job interviews to be conducted virtually. This is done by connecting the computer to the Internet, and then using some programs and tools to conduct Internet communications, whether visual or even audio.

A computer connected to the Internet allows the use of various social media such as

Facebook, Twitter, and others. These means allow users to interact with each other by sharing photos, videos, and other activities.

The computer is also used to organize phone lines, pay phone bills, and control the purity of voice calls.

3.6 Business

The business sector is one of the most important sectors in which the computer is used, due to the numerous and important services it provides for employers or workers.

Through the computer, many different actions can be performed, such as conducting online sales, transferring funds between accounts, completing large account operations, and other institutional work that requires speed and accuracy.

The computer also provides business companies with the ability to create economic forecast plans based on some of the data it is provided with. In addition, corporate computers provide protection for their data and information from theft or vandalism.

When a user surfs the browser, there is a passing of information between the server and the user's PC. It should be encrypted with modern encryption standards. It is therefore necessary to have an SSL certificate to secure online transactions.

The use of computers in business has made it easier to find employees. This is done through some specialized social media such as LinkedIn.

The computer has also made it easier to manage the company's employee records through specialized programs, as well as to prepare the company's budget, tax forms, and others.

3.7 Transportation

The computer is used in transportation, where the routes of transportation lines are controlled, as well as booking travel tickets via the computer and recently via the Internet, and booking international airline tickets anywhere in the world via the Internet.

The computer is used to control transportation, determine the take-off and direction of aircraft, and store information about workers in the field of transportation.

3.8 The industry

Computer uses are widespread in the industry, as most companies today have a wide range of uses for computers, and factories have become highly dependent on the operation of machines to ensure a high level of quality.

The use of computers in the industry has been a great necessity, as it is used as a means to allocate industrial resources more efficiently, as well as as a means to reach a larger group of potential customers. As a result, IT jobs have flourished as the industry relies on computers for its daily operations.

3.9 Entertainment

Computers are among the best sources of entertainment because they offer a wide range of options related to entertainment and entertainment. Through the computer, you can listen to music, watch some movies and videos, and talk and chat with your friends.

Today, everything related to daily life can be done with a few simple clicks, where breakfast can be ordered online, newspapers can also be read, and work from home can be done comfortably with the help of a laptop.

3.10 Engineering and military

Both the engineering and military fields are broad areas of computer use. The computer helps accomplish many operations, including:

The computer provides special programs for advanced engineering drawing, such as the design of buildings, structures, ships, planes, city planning, and design through 2D and 3D graphics.

The computer is used in the field of military industries and to control them through computerized control systems that control missile launches, military communications, military planning operations, and smart weapons.

3.11 Security systems

The computer is used in various electronic protection systems, such as surveillance cameras, which are widely used in private and government facilities in order to monitor the movement of goods and people in these areas.

Some types of computers, particularly those built with facial recognition and fingerprint, have also contributed to reducing the possibility of identity fraud.

3.12 Automation systems

Computers are used in automation systems that are concerned with the manufacture of automated robots.

It also facilitates the completion of much other work such as manufacturing and assembling auto parts, in addition to that, robots or automated programs can be used in scientific discovery tasks that are difficult for humans to carry out, such as exploring geographical areas that are inaccessible to humans.

3.13 Problem Solving

Today, the computer is used to find solutions to any problem through computer experts. Technological problems are solved by finding solutions by experts, directly or indirectly, and this affects our daily lives positively.

A computer is a vital tool for accessing and processing information and data, as it is the first window to access the Internet.

1. It is an important tool for science students, who generally rely on it in preparing their educational reports and projects.
2. It facilitates ways of communicating with others by editing and writing messages and preparing reports and documents.
3. It is an effective element in achieving success in the educational process.
4. It is a major tool in distance education, this type of education cannot be completed without the presence of a laptop or computer.
5. It helps to be familiar with the news and stay up to date, as it is a means of communicating with the outside world.

6. It helps in doing some electronic transactions, such as making payments, purchasing, and others.
7. It helps perform the tasks assigned to the user.
8. It provides tools and means to facilitate work, such as tables, worksheets, presentations, and many more.
9. It preserves and stores information away from the damaging factors of traditional methods of storage.
10. It facilitates making and storing calculations.
11. The importance of the computer also appears in filling leisure time with games and watching valuable videos, and its role in entertainment also emerges.

A computer is an electronic device that processes information. They work at such speed and accuracy that they seem to free us up from many very mechanical tasks. Following is a list of ways in which computers have come to become a very important part of our daily life.

3.14 Access to information

Computers are a device that can be used to access the internet and wide range of information for a variety of purposes

3.15 Prepare for projects

Computers are essential to prepare for school and college projects and for work reports

Typing and Editing: It helps us type and edit a lot of documents beginning with letters to family to notices, projects and variety of lists and documents

3.16 Learning

Computer assisted learning has come to become a tool for learning and has come to revolutionize the ways in which we learn.

3.17 Distance Education

It is an important requirement for distance education beginning from MOOC courses to correspondence degrees

3.18 Instant access to news

The news about various happenings are instantly updated on the internet and can be accessed by the computer

3.19 Stay updated

It helps us stay updated about anything and everything from international news to celebrity activities

3.20 Connect with people

It helps us stay connected with people through mails, chat rooms and social media

3.21 Access social media

We can access social media sites like Facebook, twitter and Instagram Employment and work from home.

It provides us access to part time employment such as freelancing and work from home options

3.22 Online transactions

We can carry out hassle free transactions through the computer and make payments anywhere and at any time

3.23 Shopping

Online shopping is emerging as one of the modes of shopping and the computer enables us to access a variety of products with literally a click of the mouse

3.24 Variety of applications

1. The computer comes with a variety of applications that come handy in our day to day life
2. Budgeting:
3. It's an effective budgeting tool and has software that help in maintaining and developing monthly budgets

3.25 Scheduling and lists

It is a good tool for making schedules and keeping lists and with timely updates help us keep on track with our work

3.26 Storing personal information digitally

We can store a lot of personal information, pictures and so on digitally on the computer and access it instantly

3.27 Leisure

They are also a part of our general leisure time activity including a variety of options like games, educational videos, movies, social media and general surfing of the web

3.28 Gaming

Gaming is something that appeals to all ages and one of the most important uses of the computer

3.29 Entertainment

It is a source for entertainment like movies, music and so onComputers are a basic necessity in today's world. We can perform a variety of functions using the computer and it is indeed the technology for the future. From managing our finances or making purchases, it has proved to be a very handy device that has transformed the ways in which we operate in society.

3.30 Uses of Computers in Education

Computers, smartphones, and cheap internet data packs have revolutionized the field of education. A data-enabled mobile phone opens the door to vast resources.

Online learning and distance education has changed the fortunes of many. The curiosity to learn and diligent efforts are sufficient to succeed. High-quality, world-class courses are available at affordable rates through MOOCs (Massive Open Online Courses) from top-notch universities. The software programs are better than print media in presenting the subject to the students.

In this way, they are more interested in learning and take the initiative to know further. It increases the quality of education that people receive. Moreover, computers have

vast storage spaces, and the durability of the study material is also high.

In specific fields like architecture and mechanical engineering, there is a paradigm shift in pedagogy. They learn and use software technologies like CAD and CAM (computer-aided design and manufacturing).

3.31 Uses of Computers in Defence

We know that the word 'computer' comes from compute and thus, they were mostly computing devices. The first computer was for the military, and the U.S. Army used it for calculating artillery firing tables.

Today, computers are used in tanks, planes, and ships to target enemy forces. They play a vital role in providing training and simulations to soldiers. They are essential to safeguard the confidential activities of the defense forces.

3.32 Uses of Computers in Medicine

Modern healthcare would become void without these wonderful machines. The hospitals require computers in all stages of treatment right from diagnosis to surgery. The advanced scans such as MRI and CT (Computerized Axial Tomography) scans help you detect life-threatening conditions.

The entire department of radiology is dependent on these electronic machines. Then we have fitness trackers and ECG bands that could warn you of imminent heart ailments and strokes.

Our doctors perform robotic surgeries by looking at a monitor. We are moving towards a time when we can swallow the computing devices in the form of a pill to get accurate images of the internal organs like the intestines.

3.33 Uses of Computers in Businesses

The business communities are always quick in adapting to the latest technologies. Today, even in small shops, electronic book-keeping and PoS(Point-of-Sale) machines are indispensable. The supermarkets have computerized inventory management systems and barcode readers.

The factories have numerous automated manufacturing processes and software packages for sales, payrolls, and logistics are readily available in the market. Moreover, we have live access to global financial markets round the clock through the internet.

We should also remember that the flourishing E-commerce industry owes its existence to the internet and mobile technologies.

3.34 Uses of Computers in Services

The data-processing and storage facility has made life more comfortable. Automation of billing, book-keeping, and security services are due to smart devices. The Information Technology sector thrives on the quick, reliable services it provides. The concept of standing in queues for paying the electricity bills and taxes is no more in practice.

Banking is highly sophisticated due to the enhancement of data storage and retrieval

technologies. ATMs, digital payments, and cashless transactions are changing the way we deal with money. Security and authentication services also are going through a sea of changes because of biometric identifications.

The use of computers in weather forecasting and disaster prediction and management is beneficial for people. It prevents loss of life and material. It is useful for farmers and tourists.

3.35 Uses of Computers in Communication

The way we communicate today is primarily due to the rapid developments in computer and internet technologies. We can control the satellites, traffic signals, locate trains, etc. from remote places. The GPS (Global Positioning System) has a myriad of applications in life.

We use Google Maps to get directions on our way, we can share our lives travel routes with the family, and we can also check the arrival of our food orders through services like zomato and Swiggy.

Instant messages, social media, video conferences, and Skype meetings attribute their existence to advanced communication systems. Emails are not for sending and receiving messages alone; companies use them as marketing tools.

3.36 Uses of Computers in Entertainment

The entertainment industry has become highly versatile due to advancements in file processing and internet technologies. Live- streaming of videos, downloading music, and advanced video games give recreation facilities at the click of a mouse.

The internet stage has also become an open venue for many amateur artists. It helps the industry people to identify and recognize raw talents. It brings in a kind of transparency in the system. People are more willing to take up music, dance, and acting as mainstream professions.

Online application process – Nowadays, the application process for almost everything – admissions to courses, job recruitments, passport, etc are done through computers. So, everyone needs a computer at one or the other point of time.

Communication – these days all type of important communication is done through emails for which one needs either a computer or a smartphone.

Education – some of the best facilities for education can be availed online at the comfort of sitting at home. Students can download educational apps and enrol for online classes and webinars too.

Defence – Computers are used extensively in defence forces for targeting weapons and finding locations.

Business – E-Commerce has changed the way businesses work. Consumers have adopted the system of buying online. Sellers like Amazon and services like Zomato have made e-commerce a daily thing for us.

Healthcare – the most advanced healthcare facilities like scans and various treatments have

been made possible by the latest technologies in computers.

News – People stay updated with the latest news which is provided to us instantly through online resources.

We can see our favorite movies and serials at any time of the day with the help of computers.
Readers can avail e-books and free downloadable editions of their favorite books through online resources.

We can talk to our friends, family, and colleagues located in any part of the world through computers with the help of Skype and Whatsapp.
We can conclude that computers which were simple machines aimed at storing and transferring data are becoming an integral part of our lives. They are not limited to banks or military operations.

These modern machines permeate our home, work, and even entertainment. It has changed the way many industries operate. For example, travelers no longer need guides, the booking process is mostly online, and people are ready to take the path less known.

We want our farmers to become modern and tap the potential of the internet to get weather updates, seed availability, and market prices.

But, these advancements have their flip side too. People tend to have health issues because of long sitting hours, constant staring at the screen, and ensuing lethargy. For youngsters, social media addiction and virtual highs seem to be a complete menace.

It is in our onus that we take the pluses of the computers alone. In the race for catching up with the latest technology that is changing in the blink of the eye, let us not forget our roots.

3.37 Summary

The accuracy rate of jobs done by computers is very high as along as the right procedures are administered. The rate of human errors goes down drastically and the human labour to stands redundant. The ease with with computers can be operated makes more and more people capable of handling such jobs. At the same time since the machine does not have its own intelligence, the decision making at critical times becomes that much more tricky since the machine does not have the ability to judge the situation.

3.38 Key Words

Internet- Internet is used as a means of communication between people in all countries of the world.

Communication - Communication between people regardless of their location, as the computer has become an effective communication tool that brings together family members, relatives, and friends, and allows job interviews to be conducted virtually

Online Shopping- Online shopping is emerging as one of the modes of shopping and the computer enables us to access a variety of products with literally a click of the mouse.

Entertainment Industry- The entertainment industry has become highly versatile due to advancements in file processing and internet technologies. Live- streaming of videos, downloading music, and advanced video games give recreation facilities at the click of a mouse.

3.39 Self Assessment Questions

1.Briefly Explain the Uses of Computers in Education
2. Examine the Uses of Computers in Medicine
3. Discuss the Uses of Computers in Defence
4. Outline the Uses of Computers in Communication
5. Describe the Uses of Computers in Entertainment?

3.40 Suggested readings

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LESSON - 4

GENERATION AND CLASSIFICATION OF COMPUTER

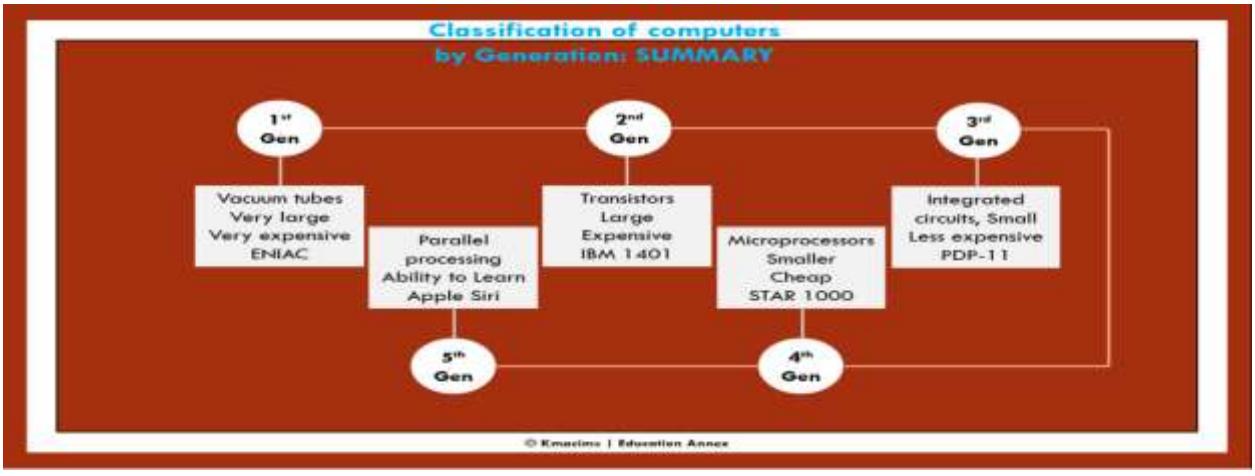
Learning objectives

- ✓ To Know the Generation of Computers
- ✓ To Understand the Classification of Computers
- ✓ To Discuss the use of Computers

Structure

4.1 Introduction

After the invention of the first computer in 1945 which filled the entire room, subsequent computers showed improved capabilities. These improved capabilities are captured in the following features:



1. Higher processing power and computation strength

2. Reduced size and power consumption
3. Lower cost of production, acquisition, and maintenance
4. Better and improved programming languages

The classification of computers by generation captured the above features per generation. This shows the chronological improvement of the computer system as technology advanced. For a comprehensive article visit the post: different generations of computers.

4.2Generation of Computers

4.2.1 First-generation computers

These computers were developed between 1945 and 1956. They are based on vacuum tubes and have the following characteristics.

Feature	Description
Vacuum tubes	Used for circuitry
Magnetic drums	Used for memory and storage
Size	Very large
Power consumption	Consume a lot of power and generates a lot of heat
Cost	Very expensive to buy and maintain
Speed	Very slow (computation time in milliseconds)
Programming language	Machine language
Input/output	Punched cards/ printouts
Examples	ENIAC, EDVAC, UNIVAC

4.2.2 Second-generation computers

The second-generation computers were developed between 1956 and 1963 with transistors replacing vacuum tubes. Some of the characteristics include:

Feature	Description
Transistors	Used for circuitry
Magnetic core technology	Used stored program concept (instructions stored in memory), magnetic tape for mass storage
Size	Large

Power consumption	Consume less power and generates less heat than 1st generation
Cost	Less expensive than first-generation
Speed	Slow (computation time in microseconds)
Programming language	Assembly language
Input/output	Punched cards/ printouts
Examples	IBM 1401, PDP-1, UNIVAC 1107

4.2.3 Third-generation computers

Third-generation computers were developed between 1964 and 1971 with integrated circuits. Other notable characteristics are.

Feature	Description
Integrated circuits	Used for circuitry
Hardware/ software	The advent of operating systems to interface between hardware/ software
Size	Small (magnetic tape for storage)
Power consumption	Less power and less heat
Cost	Cheaper and available to the public
Speed	high (computation time in nanoseconds)
Programming language	High-level language
Input/output	keyboards/ monitors
Examples	IBM 360s, PDP-11, Honeywell 6000s

4.2.4 Fourth-generation computers

This generation took place around 1971. It marked the advent of microprocessors in place of integrated circuits, and it is still in use today. Other major characteristics include.

Feature	Description
Microprocessor	Used as single processing power
RAM and cache technology	Stores computation instructions for the CPU
Size	Small and portable
Power consumption	Less power and heat
Cost	Less expensive
Speed	Fast (computation time in picoseconds)
Programming language	High-level language
Input/output	Keyboard, mouse,…/monitor, printer,…
Examples	Altair 8800, STAR 1000, CRAY-1

4.2.5 Fifth-generation computers

The movement for the fifth-generation computers began in Japan in 1982 through the Ministry of International Trade and Industry. The project was initiated to create computers with parallel computing technology, pattern processing, and logic programming language.

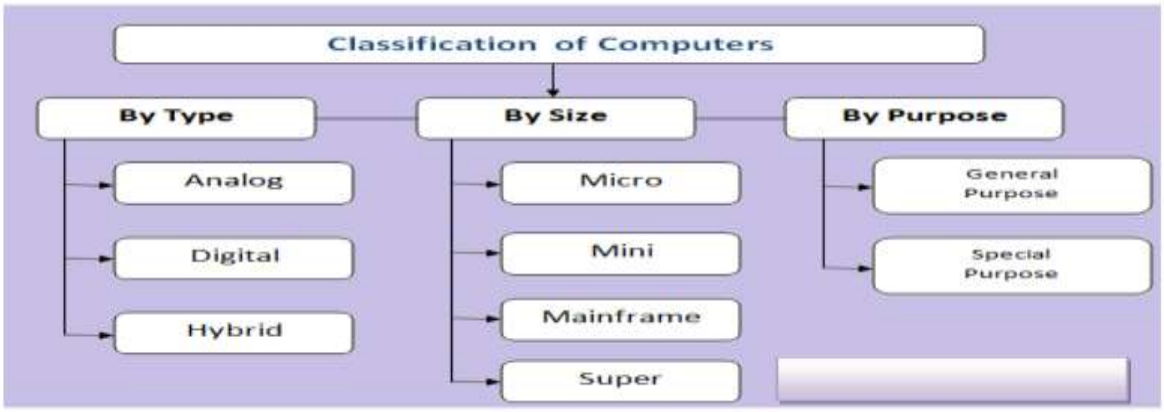
Feature	Description
Processing	Parallel processing & computing technology
Purpose	Capable of learning and organizing
Cost	Expensive
Speed	Very fast
Programming language	Logic programming & algorithms
Example	Apple Siri

Fifth-generation is used to refer to the computers that are capable of learning and organizing based on human behavioral algorithms. They are in continuous development and are based on Artificial Intelligence and Machine Learning.

These computers and machines are developed to perform some of the basic tasks of man. They use parallel processing to enhance speed and achieve real-time results. An example of natural language processing technology is Apple's Siri, Google Assistance, and Microsoft Cortana.

Each of these generations of computers has its distinguishing features which were explained in this tutorial. Check out the classification of computers by type.

4.3 Classification of Computers



4.3.1 Analogue computers

Analogue computers are designed to process analogue data. Analogue data is continuous data that changes continuously and cannot have discrete values. We can say that analogue computers are used where we don't need exact values always such as speed, temperature, pressure and current.

Analogue computers directly accept the data from the measuring device without first converting it into numbers and codes. They measure the continuous changes in physical quantity and generally render output as a reading on a dial or scale. Speedometer and mercury thermometer are examples of analogue computers.

Advantages of using analogue computers

It allows real-time operations and computation at the same time and continuous representation of all data within the rage of the analogue machine.

In some applications, it allows performing calculations without taking the help of transducers for converting the inputs or outputs to digital electronic form and vice versa.

The programmer can scale the problem for the dynamic range of the analogue computer. It provides insight into the problem and helps understand the errors and their effects.

4.3.2 Digital Computer

Digital computer is designed to perform calculations and logical operations at high speed. It accepts the raw data as input in the form of digits or binary numbers (0 and 1) and processes it with programs stored in its memory to produce the output. All modern computers like laptops, desktops including smart phones that we use at home or office are digital computers.

Advantages of digital computers

1) It allows you to store a large amount of information and to retrieve it easily whenever you need it.
2) You can easily add new features to digital systems more easily.
3) Different applications can be used in digital systems just by changing the program without making any changes in hardware
4) The cost of hardware is less due to the advancement in the IC technology.
5) It offers high speed as the data is processed digitally.
6) It is highly reliable as it uses error correction codes.
7) Reproducibility of results is higher as the output is not affected by noise, temperature, humidity, and other properties of its components.

4.3.3 Hybrid Computer

Hybrid computer has features of both analogue and digital computer. It is fast like an analogue computer and has memory and accuracy like digital computers. It can process both continuous and discrete data. It accepts analogue signals and converts them into digital form before processing. So, it is widely used in specialized applications where both analogue and digital data is processed. For example, a processor is used in petrol pumps that convert the measurements of fuel flow into quantity and price. Similarly, they are used in airplanes, hospitals, and scientific applications.

Advantages of using hybrid computers

1) Its computing speed is very high due to the all-parallel configuration of the analogue subsystem.
2) It produces precise and quick results that are more accurate and useful.
3) It has the ability to solve and manage big equation in real-time.
4) It helps in the on-line data processing.

4.3.4 Supercomputer

Supercomputers are the biggest and fastest computers. They are designed to process huge amount of data. A supercomputer can process trillions of instructions in a second. It has thousands of inter connected processors. Super computers are particularly used in scientific and engineering applications such as weather forecasting, scientific simulations and nuclear energy research. The first supercomputer was developed by Roger Cray in 1976.

Characteristics or applications of Supercomputers

1) It has the ability to decrypt your password to enhance protection for security reasons.
2) It produces excellent results in animations.
3) It is used for virtual testing of nuclear weapons and critical medical tests.
4) It can study and understand climate patterns and forecast weather conditions. It can run in NOAA's system (National Oceanic and Atmospheric Administration) that can execute any type of simple and logical data.
5) It helps in designing the flight simulators for pilots at the beginner level for their training.
6) It helps in extracting useful information from data storage centres or cloud system. For example, in insurance companies.
7) It has played a vital role in managing the online currency world such as stock market and bit coin.
8) It helps in the diagnosis of various critical diseases and in producing accurate results in brain injuries, strokes, etc.

9) It helps in scientific research areas by accurately analyzing data obtained from exploring the solar system, satellites, and movement of Earth.
10) It also used in a smog control system where it predicts the level of fog and other pollutants in the atmosphere.

4.3.5 Mainframe computer

Mainframe computers are designed to support hundreds or thousands of users simultaneously. They can support multiple programs at the same time. It means they can execute different process simultaneously. These features of mainframe computers make them ideal for big organizations like banking and telecom sectors, which need to manage and process high volume of data.

Mainframe computers are designed to support hundreds or thousands of users simultaneously. They can support multiple programs at the same time. It means they can execute different processes simultaneously. These features of mainframe computers make them ideal for big organizations like banking and telecom sectors, which need to manage and process a high volume of data that requires integer operations such as indexing, comparisons, etc.

Characteristics of Mainframe Computers

1. It can process huge amount of data, e.g. millions of transactions in a second in the banking sector.
2. It has a very long life. It can run smoothly for up to 50 years after proper installation.
3. It gives excellent performance with large scale memory management.
4. It has the ability to share or distribute its workload among other processors and input/output terminals.
5. There are fewer chances of error or bugs during processing in mainframe computers. If any error occurs it can fix it quickly without affecting the performance.
6. It has the ability to protect the stored data and other ongoing exchange of information and data.

Applications of mainframe computers

In health care, it enabled hospitals to maintain a record of their millions of patients in order to contact them for treatment or related to their appointment, medicine updates or disease updates.

In the field of defense, it allows the defense departments to share a large amount of sensitive information with other branches of defense.

In the field of education, it helps big universities to store, manage and retrieve data related to their courses, admissions, students, teachers, employees and affiliated schools and colleges.

In the retail sector, the retail companies that have a huge customer base and branches use mainframe computers to handle and execute information related to their inventory management, customer management, and huge transactions in a short duration.

4.3.6 Minicomputer

It is a midsize multiprocessing computer. It consists of two or more processors and can support 4 to 200users at one time. Minicomputers are used in institutes and departments for tasks such as billing, accounting and inventory management. A minicomputer lies between the mainframe and

microcomputer as it is smaller than mainframe but larger than a microcomputer.

Characteristics of minicomputer

1. It is light weight that makes it easy to carry and fit anywhere.
2. It is less expensive than mainframe computers.
3. It is very fast compared to its size.
4. It remains charged for a long time.
5. It does not require a controlled operational environment.

Applications of minicomputers

A minicomputer is mainly used to perform three primary functions, which are as follows:

Process control

It was used for process control in manufacturing. It mainly performs two primary functions that are collecting data and feedback. If any abnormality occurs in the process, it is detected by the minicomputer and necessary adjustments are made accordingly.

Data management: It is an excellent device for small organizations to collect, store and share data. Local hospitals and hotels can use it to maintain the records of their patients and customers respectively.

Communications Portal

It can also play the role of a communication device in larger systems by serving as a portal between a human operator and a central processor or computer.

PALMTOP

A small computer, that literally fits in your palm. Compared to full-size computers, palmtops are everely limited, but they are practical for certain functions such as phone books and calendars. Palmtops that use a pen rather than a keyboard for input are often called hand-held computers or PDAs.

Because of their small size, most palmtop computers do not include disk drives. However, many contain PCMCIA slots in which you can insert disk drives, modems, memory, and other devices. Palmtops are also called PDAs, hand-held computers and pocket computers.

DESKTOP

A computer designed to fit comfortably on top of a desk, typically with the monitor sitting on top of the computer. Desktop model computers are broad and low, whereas tower model computers are narrow and tall. Because of their shape, desktop model computers are generally limited to three internal mass storage devices. Desktop models designed to be very small are sometimes referred to as slim line models.

Workstation

Workstation is a single user computer that is designed for technical or scientific applications. It has a faster microprocessor, a large amount of RAM and high speed graphic adapters. It generally performs a specific job with great expertise; accordingly, they are of different types such as graphics workstation, music workstation and engineering design workstation.

Characteristics of workstation computer:

1) It is a high-performance computer system designed for a single user for business or professional use.
2) It has larger storage capacity, better graphics, and more powerful CPU than a personal computer.
3) It can handle animation, data analysis, CAD, audio and video creation and editing.

4.3.7 Microcomputer

Microcomputer is also known as a personal computer. It is a general-purpose computer that is designed for individual use. It has a microprocessor as a central processing unit, memory, storage area, input unit and output unit. Laptops and desktop computers are examples of microcomputers. They are suitable for personal work that may be making an assignment, watching a movie, or at office for office work.

Characteristics of a microcomputer:

1. It is the smallest in size among all types of computers.
2. A limited number of software can be used.
3. It is designed for personal work and applications. Only one user can work at a time.
4. It is less expansive and easy to use.
5. It does not require the user to have special skills or training to use it. Generally, comes with single semiconductor chip.
6. It is capable of multitasking such as printing, scanning, browsing, watching videos, etc.

TABLET PC

A tablet is a type of notebook computer that has an LCD screen on which the user can write using finger and swipe actions or by using a special-purpose pen, or stylus. All user input is directly via the LCD screen and not a keyboard or mouse. On a tablet computer, handwriting is digitized and can be converted to standard text through handwriting recognition, or it can remain as handwritten text. The stylus also can be used to type on a pen-based key layout where the lettered keys are arranged differently than a QWERTY keyboard. Tablet PCs can be equipped with a keyboard and/or a mouse for input.

The tablet PC relies on digital ink technology, where a digitizer is laid under or over an LCD screen to create an electromagnetic field that can capture the movement of the special-purpose pen and record the movement on the LCD screen. The effect is like writing on paper with liquid ink Servers

These are types of computers used to provide resources, services, and functionality to client computers in a server-client network model. Resources provided are based on the functions of a particular server, which may fall under these categories:

a. File server
b. Database server
c. Print server
d. FTP servers
e. Application server
f. Web server

Their sizes will depend on purpose and tasks in the network. Of course bigger and

more multitasking installations will require multiple system and storage installation.

A common errant is that desktop systems can be used as servers. Far from it, true server systems are specialized computers with abilities far beyond what personal computers can deliver.

Servers are optimized to run 24 hours and are capable of hot swapping of storage and other hardware without having to shut down the system.

4.4 Summary

Computer is an advanced electronic device that takes raw data as an input from the user and processes it under the control of a set of instructions (called program), produces a result(output), and saves it for future use. This tutorial explains the foundational concepts of computer hardware, software, operating systems, peripherals, etc. along with how to get the most value and impact from computer technology.

4.5 Key words

Analogue computers - Analogue computers directly accept the data from the measuring device without first converting it into numbers and codes.

Digital computer - Digital computer is designed to perform calculations and logical operations at high speed. It accepts the raw data as input in the form of digits or binary numbers (0 and 1) and processes it with programs stored in its memory to produce the output.

Hybrid computer - Hybrid computer has features of both analogue and digital computer. It is fast like an analogue computer and has memory and accuracy like digital computers. It can process both continuous and discrete data.

Super computers- Super computers are the biggest and fastest computers. They are designed to process huge amount of data. A supercomputer can process trillions of instructions in a second. It has thousands of interconnected processors.

Mainframe computers - Mainframe computers are designed to support hundreds or thousands of users simultaneously. They can support multiple programs at the same time. It means they can execute different processes simultaneously.

Palmtop A small computer, that literally fits in your palm. Compared to full-size computers, palmtops are severely limited, but they are practical for certain functions such as phone books and calendars.

Workstation - Workstation is a single user computer that is designed for technical or scientific applications. It has a faster microprocessor, a large amount of RAM and high speed graphic adapters.

Microcomputer- Microcomputer is also known as a personal computer. It is a general-purpose computer that is designed for individual use

4.6 Self Assessment Questions

1. Briefly Explain the Generation of Computers
2. Discuss the Classification of Computers?

3. Outline the Characteristics and application of Hybrid Computer
4. Describe the Characteristics and application of Mainframe computer
5. State the Characteristics and application of Mini computer

4.7 Suggested Readings

1. James A. O'Brien & George M. Marakas(2011) Management Information Systems Tenth Edition Mc. Graw Hilll IRWIN.
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LESSON 5

INPUT AND OUTPUT DEVICES

Objectives of the lesson

- ✓ To study the Input Devices
- ✓ To Understand the Output Devices
- ✓ To Learn the Printer and Plotters
- ✓ To Identify the Microfilm Devices

Structure

5.0 Introduction

A number of input/output devices are used with many types of microcomputers. Many of these are less complex versions of I/O devices that have been available for larger computer systems. The principal difference is that because they are intended for use with

microcomputers, they are significantly slower and substantially cheaper.

5.1 Input Devices

5.1.1 Keyboards

The most common of all input devices is the keyboard. Several versions of keyboards are available. The best and most expensive of these is the full-stroke keyboard. This is ideal for word processing and other volume data and program entry activities. This type of keyboard is available with most mainframe computer terminals or the expensive microcomputer systems.

Some popular microcomputers offer enhanced keyboard for easy entry of numbers. This is accomplished with a smaller group of keys known as a numeric keypad at the right of the keyboard. These keys generally consist of the digits, a decimal point, a negative sign, and an ENTER key. This type of keyboard is ideal for accounting operations, which require a large volume of numbers to be entered.

Keyboards generally utilize integrated circuits to perform essential functions, such as determining the combination of 1s and 0s, or binary code, to send to the CPU, corresponding to each key depressed, switching between shifted and non-shifted keys, repeating a key code if a key is held down for a prolonged period of time, and temporarily storing or "buffering" input when keys are typed too fast.

The keyboard arrangement provided as standard on most keyboards is the QWERTY arrangement, named for the six letters beginning the row at the top left of the keyboard. This arrangement was chosen intentionally to slow expert typists, since those who typed too fast would cause the keys on a mechanical typewriter to jam. Slowing down the typist was accomplished by scattering the most used around the keyboard, making frequently used combinations of letters awkward and slower to type. This QWERTY keyboard arrangement has been used for nearly a century.

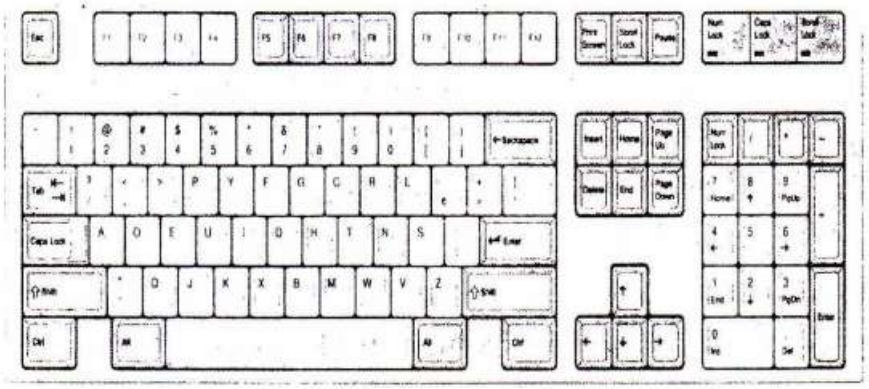
The Dvorak Simplified Keyboard (DSK) arrangement, designed in 1932 by August Dvorak, is the result of extensive ergonomic studies. Dvorak noted that with the QWERTY keyboard arrangement, typists used the weakest fourth and fifth fingers of their left hand a large proportion of the time.

Thus, Dvorak rearranged the keyboard so that the five more frequently used vowels (a, o, e, u, and i) and the five most frequently used consonants (d, h, t, n, and s) were positioned on the home row where the fingers of the left and right hands rest, respectively Thus, 70 percent of the typing is done on the home row. He then placed the next most frequently used characters in the row above the home row and the least frequently used characters in the row below the home row. This resulted in a reduction of finger movement of approximately 80 percent and overall, an increase in productivity of nearly 40 percent.

Expert typists and word processors generally agree that using the Dvorak arrangement increases productivity while simultaneously decreasing fatigue. The world's fastest typing speed, nearly 200 words per minute, was achieved on a Dvorak keyboard. Despite these improvements the QWERTY keyboard arrangements is still the most common because of the difficulty of overcoming inertia and retraining. In the mean while, microcomputer manufacturers and software vendors are producing software that will convert your keyboard from QWERTY to Dvorak, and back again at will. To date, larger computer systems employ

the traditional QWERTY arrangement only

Input and Output Devices



5.1.2 Punched Card

The punched card has served as an input medium to automated computational devices. It has undergone little or no change since that time, and most companies have phased out and replaced it with the more efficient data entry media. Among the punched card devices still in use is the punched card reader. The reading of punched cards takes place at speeds ranging from hundred fifty to more than two thousand five hundred cards per minute.

5.1.3 Key-to-Tape and Key-to-Disk Systems

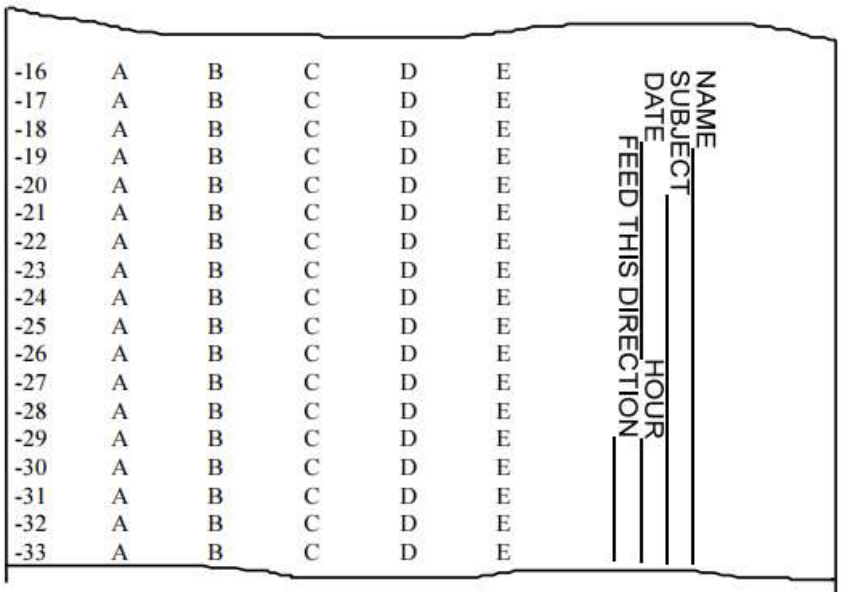
In a key-to-tape system, data entered at a keyboard are recorded directly on magnetic tape. The magnetic tape used is similar to the tape cartridge or cassette used with home recorders. Accuracy is verified by placing the recording tape into a magnetic tape verifier and having the original data retyped. Magnetic tape encoders and verifiers are generally housed in the same physical unit. Errors detected are corrected simply by erasing the mistakes and substituting the correct character(s).

5.1.4 Character Readers

A character reader is capable of accepting printed or typed characters from source documents and converting these data into a computer acceptable code. Currently available high-speed character readers are capable of reading source documents at rates of up to several thousand documents per minute and are costly. The three basic types of character readers are magnetic-ink, optical mark, and optical character readers.

5.1.5 Magnetic-ink Character Readers

Magnetic-Ink Character Recognition (MICR) was developed by the Stanford Research Institute for use by the world's largest bank, the Bank of America. This system can read data prerecorded on checks and deposit slips with a special ferrite-impregnated ink. The magnetized characters can be read and interpreted by MICR equipment.



Portion of a special-purpose optical mark form

5.1.6 Optical Mark Readers

Optical mark readers (OMR) optically read marks on carefully printed forms. Optical mark forms are relatively expensive, as they must be printed with exact tolerances so that the marks will up under the optical sensing devices when read The most popular use of such devices is optical character readers for scoring examinations in educational institutions.

5.1.7 Optical Character Readers (OCR)

Optical character recognition (OCR) devices can convert data from source documents to a machine-recognizable form. Current applications of optical scanning include billing, insurance premium notices, and charge sales invoices. At present, on OCR device can reliably read and interpret script or handwriting. However, some can read handwriting provided that certain general guidelines are observed when the data are written. Generally, optical character readers are limited with respect to hand-written characters and can only read handwritten digits and some symbols. Many OCR devices are available for the reading of typed characters, including digits, letters and some special characters. Not all printed characters can be read reliably on OCR readers. Generally, each reader is capable of reading only selected character styles.

Even if the character style and spacing are acceptable, errors can result from reading a character that is not written perfectly. To reduce such errors, OCR devices generally compare the pattern read with the patterns to all acceptable character. The read character is assumed to be the character whose stored pattern most closely matches the read pattern.

Because of the high cost of OCR devices, they are uneconomic unless a substantial number of documents are to be processed each day. CD, Web camera, disk drive, ATM, Scanner and bar code scanner can all be used as input devices. Pointing Systems Computer users frequently find it easier to point to something on a screen or at an item of text or graphical material they are entering into the computer, A number of devices are available to assist in fulfilling this need.

Various pointing input devices.

5.1.8 Light Pen

The earliest pointing device is the light pen. This device is placed close to a screen or monitor and turned on. A photo sensor inside the light pen detects the scanning beam sweeping back and forth across the screen. Accompanying circuitry converts the pen's reading into the position of the pen on the screen. Light pens are used to select items from a list or menu displayed on the screen. Light pens are used to select items from a list or menu displayed on the screen and to draw graphic displays on the video screen.

5.1.9 Digitizer Pad

A digitized pad looks like a graph pad with a pointer. It functions like a light pen on a display screen except that the pad is mounted horizontally. As the pointer is moved on the pad, the corresponding point on the screen is illuminated. The digitized pad is useful in converting graphic input, such as charts, graphs, and blueprints into patterns that can be manipulated and stored by the computer.

5.1.10 Mouse

A mouse is a hand-movable device that controls the position of the cursor on a screen. It has a box with buttons on the top and a ball on the bottom. The box is placed on a flat surface, with the user's hand over it. The ball's movement on the surface causes the cursor to move.

5.1.11 Joystick and Trackball

Joysticks are used with video games for user input. These devices may also be used to move the cursor around a screen to facilitate input to a graphical display. A trackball is similar in operation to the joystick. It uses a billiard-sized ball to position the cursor. Several keyboard manufacturers have integrated them directly into their keyboards.

5.1.12 Touchscreen

Touchscreen detects the touch of a human finger. One popular technique used to detect the touch of a finger utilizes infrared light beams. In this technique, infrared light beams shine horizontally and vertically on the face of the screen. A pointing finger interrupts both horizontal and vertical beams, pointing its exact location.

5.1.13 Pen drive

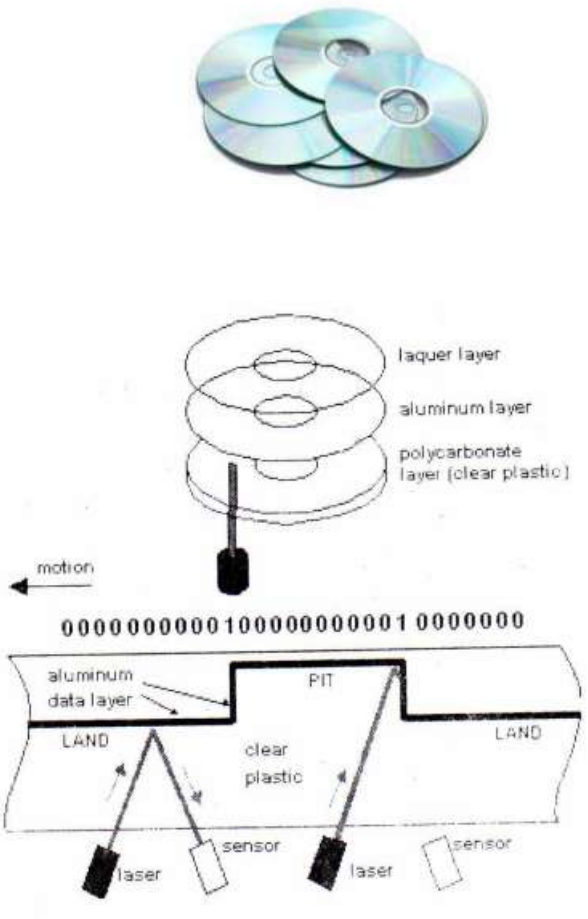
A pen drive is another name for a USB flash drive. Other names are flash drive. USB flash drive, Thumb drive, etc. They are devices that allow storage of computer files that you can remove and take from computer to computer. The price of the driver is determined by the size of its memory measured in megabytes or gigabytes. While 128 megabyte drivers used to be considered large, current pen drivers sizes can reach 1,2,4 or more gigabytes. The drivers inserted in the computers USB ports and are automatically recognized on PC operating systems beyond Windows 98 (which needs a separate installation of drivers). Pen drives can also have full blown application on them which are written in what is called U3 compatible software.

5.1.14 Scanner

In computing an image scanner often abbreviated to just scanner is a device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image. Common examples found in offices are variations of the desktop (or flatbed) scanner where the document is placed on a glass window for scanning. Hand-held scanners, Where the device is moved by hand , have evolved from text scanning "wands" to 3D scanners used for industrial design, reverse engineering, test and measurement, orthotics, gaming and other applications Mechanically driven scanner that move the document are typically used for large-format documents, where a flatbed design would be impractical.

5.1.15CD-ROM

Pronounced see-dee-rom. Short for Compact Disc-Read-only Memory, a type of optical disk capable of shorting large amounts of data up to 1GB, although the most common size is 650 MB (megabyte). A single CDROM has the storage capacity to 700 floppy disks, enough memory to store about 300,000 text pages. CD-ROMs are stamped by the vendor, and once stamped, they cannot be erased and filled with new data. To read a CD, you need a CD-ROM player. All CD-ROMs conform to a standard size and format, so you can load any type of CD-ROM into any CD-ROM player. In addition, CD-ROM players are capable of playing audio CDs, which share the same technology. CD-ROMs are particularly well-suited to information that requires large storage capacity. This includes large software applications that support color, graphics, sound, and especially video and are well suitable for tutoring,



Composition of a CD.

5.2 Output Devices

5.2.1 Monitors

It is the most commonly used display device. The monitor, utilizes a cathode ray tube (CRT). CRT monitors generally produce images by the raster-scan method. In this method, an electron beam varying in intensity, is moved back and forth horizontally across the face of the monitor. As the beam is directed to each spot on the phosphor-coated screen, it illuminates the spot in proportion to the voltage applied to the beam. Each spot represents a picture element or pixel. When the electron beam has scanned the entire screen and illuminated each pixel, one can see a complete image. The image that can be seen is the one traced on the retinas of eyes by the light beam. However, this image will fade unless it is refreshed. Thus, the electron beam must scan the screen very rapidly (a minimum of 60 times per second), so that the intensity of the image remains approximately the same and the screen does not appear to flicker.

The screen resolution of a particular monitor is determined by the number of pixels that make up the screen. Monitors are currently available with 64,000 to more than 2 million pixels per screen. The greater the resolution of a monitor the greater the storage demand on the computer. This is because the image must be stored in memory before it can be displayed. Two techniques used to store computer images are: bit-mapped and character-addressable.

In a bit-mapped display, each pixel is uniquely addressable. Information must be stored for each pixel on the screen. This technique needs quite a large computer memory and

provides the most detailed display. For graphical applications, such as CAD/CAM, this detail is essential. However, for applications such as word processing, a characteraddressable display is appropriate. In a character addressable display, the screen is divided into character positions. Only the characters to be displayed are stored in memory. As each character is retrieved from memory, it is converted into a pattern of dots or pixels by a special character generator module.

5.2.2 Monochrome or colour

Some monitors display images in only one colour while others are capable of producing images in colours. Monochrome monitors use a single electron beam and display one colour, generally green, amber, or white, on a black background. The phosphor composition of the screen determines the colour. Color monitors produce multi-colour images by combining the red, blue, and green colors in varying intensities. Each pixel is made up of three colour dots: red, blue, and green. It will appear to glow in different colours depending on the intensity of each individual dot in the pixel. Color monitors are commonly referred to as RGB monitors since they employ three election beams, one for each colour. Colour monitors are categorized as CGA, EGA, VGA and SVGA depending on the resolution. CGA monitors provide the least resolution (approximately 300 × 200 Pixels) and SVGA monitors provide the greatest resolution (1000 × 800 pixels and greater).

5.2.3 Monitor interface

A monitor requires an appropriate interface to communicate with a computer. For example, a colour graphics interface board is needed for a color monitor. This interface will generally not work with a monochrome monitor and might even damage it. Dozens of monitor interface boards are available for use with microcomputers. A caution must be exercised to match the interface to both the monitor and the computer. Using a television: Some smaller microcomputer systems can be used with a standard television. The basic difference between a monitor and a television set is that the resolution of a television is substantially less than that with a monitor. Also the television requires the use of a modulator to interface the computer output with the television. The modulator combines the separate audio and visual signals sent by the microcomputer into a single modulated signal as required by a television. Most inexpensive computer systems designed for use with a television set generally have a built-in modulator.

5.2.4 Flat-Panel Displays

For laptop computers more compact, low-power, durable monitors are used. A number of flat-panel display technologies are available for this. The most common are the plasma and liquid crystal displays.

5.2.5 Plasma displays

A plasma display consists of an ionized neon or argon gas (plasma) sealed between two glass plates. One plate encases a set of fine horizontal wires and the other a set of vertical wires. Pixels are formed by the intersections of the horizontal and vertical wires. A single pixel can be turned on by sending a current through its horizontal and vertical wires. This causes the gas between the wires to produce an amber glow. The images produced by plasma displays are generally very clear, and not subject to the flicker. Plasma displays are generally more expensive than the CRT displays.

5.2.6 Liquid crystal displays

Liquid crystal displays (LCDs) have been used for several years in calculators and

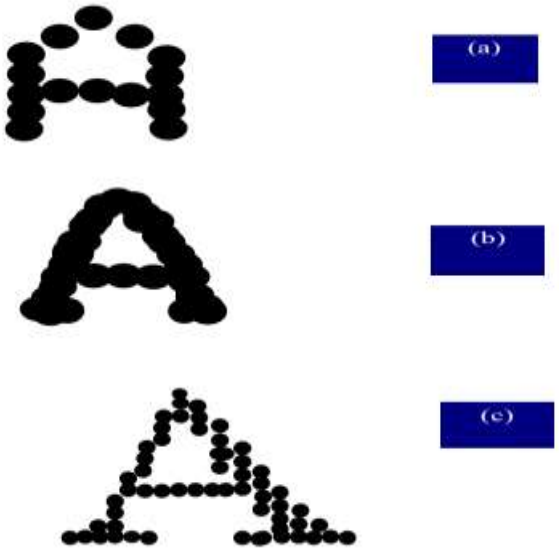
digital watches. A thin layer of a liquid crystal substance is suspended between two thin sheets of polarized glass and separated by a wire grid into tiny squares. As current is applied to the wires the liquid crystal substance within the square changes from clear to opaque or black. The thousands of clear and black squares produce patterns of characters. The disadvantage of LCD displays is lack of brightness and resolution as compared to CRT and plasma displays. The quality of the LCD display depends on the surrounding light and the viewing angle. It is sharpest and clearest when viewed in brightness from the front.

5.3 Printers

The printer is the most common output device. It produces permanent visual record of the data output from a computer. It is capable of producing business reports and documents currently available. Printers are capable of printing from 150 to over 20,000 lines per minute, with each line having up to 150 characters. Thus, a maximum printing speeds of approximately 50,000 characters per second is possible. Printers print on plain paper or on specially prepared single-or multiple copy forms, such as invoices, stationery, labels, checks, bills and other special-purpose forms used in business and industry. They can print both text and graphics in black and white or in colour. Printers can be subdivided into two broad categories, impact and nonimpact. The impact printers are the most common.

5.3.1 Impact Printers

In impact printers, printing occurs as a result of a hammer striking a character form and the character form in turn striking an inked ribbon, causing the ribbon to press an image of the character on paper. Character printer devices print one character at a time at speeds of about 10 to 500 characters per second. The fastest of these printers is the wire or dot-matrix printer. It prints characters made up of a pattern of dots formed by the ends of small wires Figure 4.6 shows the letter "A" as printed with different densities. By extending certain wires beyond the others, a dot pattern can be created that gives the appearance of numbers, letters or special characters.



Dot Matrix Printer

These extended wires are pressed against an inked ribbon to print the characters on

the paper. Some slower and less expensive matrix printers print a character as a series of columns each one dot wide. It can be used to print special character shapes that can be used with graphics.

For a typewriter-quality output, a special dot-matrix or daisy metal print element, similar in appearance to the arrangement of petals on a daisy flower. This element is rotated until the correct character is in position, and then pressed against an inked ribbon. The process is repeated for each character to be printed on a line. Typical for such printers range from 25 to 100 characters per second.

Impact character printers are the common output devices used with personal and small business microcomputer systems. They are significantly cheaper than the line printers. Impact line printers, capable of printing a whole line at a time, employ print wheels or a moving chain or drum. The print-wheel printer consists of print wheels, each containing a full complement of digits and alphabetic characters in addition to a set of special characters. For printing, all print wheels rate positioned to represent the data to be printed on one line. They then impact simultaneously at a speed of about 150 lines per minute. Impact line printers and the chain and drum printers are commonly used. As the print chain or drum revives, each character is printed as it comes into position. Up to 150 characters per line can be printed at speeds of up to 2,500 lines per minute. Impact line printers are used almost exclusively to support larger computer systems.

5.3.2 Nonimpact Printers

Nonimpact line printers, using laser, xerographic, electrostatic, or ink jet methods are the fastest printers. Before the development of the ink jet and laser printers, nonimpacts were not heavily used, for several reasons:

- Special and more expensive paper was required.
- Printed output was not as sharp or as clear as with impact printers.
- Only a single-part form can be printed at a time.
- Output could not be easily or satisfactorily copied on office copiers.

Electrostatic and xerographic printers place a pattern of the desired character on sensitized paper by means of an electric current or beam of light. The paper then passes through a powdery black substance called toner, which contains dry ink particles. The ink particles are attracted to the exposed paper and the character becomes visible. These printers can print at speeds of from 3500 to 20,000 lines per minute.

The laser printer form characters by projecting a laser beam of dotmatrix pattern on a drum surface. Toner is then attracted to the area exposed by the laser and transferred to the paper. The paper is then passed over a heating element which melts the toner to form a permanent character. Many types of ink jet printers are available. The simplest of these contains a series of ink jet nozzles in the form of a matrix. Vibrating crystals force ink droplets, roughly the diameter of a human hair, from selected nozzles to form an image in the same manner as an image is formed by a matrix printer. Different coloured inks may be used and combined to form additional colors.

Several hundred nozzles are employed in the more sophisticated ink jet printers to direct a continuous stream of droplets across the page to form an image. These charged ink droplets travel at speeds of up to 40 miles per hour as they move between a set of plates that

deflect the droplets. Droplets not needed are electrostatically attracted away from the paper for reuse. A stream of more than 100,000 droplets can form approximately 200 characters per second.

5.4 Plotters

An inexpensive portable plotter capable of generating multicolor plots from data is stored on magnetic tape or disk. Plotters with multicolor capabilities generally use a writing mechanism containing several pens, each capable of producing a different color. Some devices for automated drafting are equipped with plotting surfaces larger than 10 square feet and cost as much as a minicomputer system. Whether an application is a general one (such as designing, mapping, or plotting schematics) or more specialized (such as three-dimensional data presentation, structural analysis, contouring, or business charts), there are plotters to do the tricks.

5.5 Microfilm Devices

Computer output microfilm (COM) devices convert computer output to a human-readable form stored on rolls of microfilm or as microfilm frames stored on cards called microfilm. At speeds of 10,000 to over 30,000 lines per minute, COM is one of the fastest computer output techniques more than ten times faster than the fastest impact printer. A single roll of microfilm can store approximately 2000 frames and costs less than half the cost to print the same amount of data on paper. Because of the high cost of COM equipment, it is generally only practical for larger businesses or industries generating approximately several thousand documents per day. COM devices are commonly used in libraries, mail-order concerns, defense installations, government agencies, and similar, large operations.

5.6 Summary

A broad range of industrial and consumer products use computers as control systems. Simple special-purpose devices like microwave ovens and remote controls are included, as are factory devices like industrial robots and computer-aided design, as well as general-purpose devices like personal computers and mobile devices like smartphones. Computers power the Internet, which links billions of other computers and users. Early computers were meant to be used only for calculations. Simple manual instruments like the abacus have aided people in doing calculations since ancient times. Early in the Industrial Revolution, some mechanical devices were built to automate long, tedious tasks, such as guiding patterns for looms. More sophisticated electrical machines did specialized analog calculations in the early 20th century

5.7 Key words

Magnetic-ink Character Readers - Magnetic-Ink Character Recognition (MICR) was developed by the Stanford Research Institute for use by the world's largest bank, the Bank of America

Optical Mark Readers - Optical mark readers (OMR) optically read marks on carefully printed forms. Optical mark forms are relatively expensive, as they must be printed with exact tolerances.

Optical character recognition (OCR) devices can convert data from source documents to a machine-recognizable form.

A digitized pad looks like a graph pad with a pointer. It functions like a light pen on a

display screen except that the pad is mounted horizontally

Joysticks are used with video games for user input. These devices may also be used to move the cursor around a screen to facilitate input to a graphical display

Touchscreen detects the touch of a human finger. One popular technique used to detect the touch of a finger utilizes infrared light beams

Monochrome monitors use a single electron beam and display one colour, generally green, amber, or white, on a black background

A plasma display consists of an ionized neon or argon gas (plasma) sealed between two glass plates.

Nonimpact line printers, using laser, xerographic, electrostatic, or ink jet methods are the fastest printers.

Impact printers, printing occurs as a result of a hammer striking a character form and the character form in turn striking an inked ribbon, causing the ribbon to press an image of the character on paper,

5.8 Self Assessment Question

1. Briefly Explain the Input Devices
2. Critically Examine the Output devices
3. Examine the different types of Printer and Plotters
4. Explain the Micro film Devices

5.9 Suggested Readings

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LESSON- 6

STORAGE DEVICES AND CENTRAL PROCESSING UNIT

Learning objectives

- ✓ To Understand the Types of Computer Storage
- ✓ To Study the Magnetic Storage Devices
- ✓ To Learn the Central Processing Unit
- ✓ To Know the Computer Configuration System

Structure

6.1 Introduction

The storage devices are the components of a computer system that holds data and orders that will be analyzed. Secondary storage is a component of computer hardware that stores data to process the results of computing activity. A system will not allow functioning or even load up without a storage device. In other terms, a data store is a piece of equipment that is used to transfer, store, or extract data files. It may also temporarily and permanently

store data and information.

A storage device is among the essential components of any computer system, and it comes in a variety of shapes and sizes depending on the requirements and functionality. It holds almost all of the large datasets in a computer, except the exception of hardware-software. A storage device comes in a variety of shapes and sizes; for example, a computer has numerous file systems such as a hard drive, RAM, and cache. These have also optical disc drives and USB drives that may be linked outside. There are two sorts of storage systems that store data: main and secondary.

6.2 Types of computer storage

Primary storage devices: primary storage is also referred to as internal memory. This is a component that is present inside the CPU which is used to store the temporary files and process them to get immediate results. The best examples for primary storage devices are RAM (Random access memory) and ROM (Read-only memory).

Secondary storage devices: From the name itself this can be known that this is a type of secondary storage which is external to the computer system. It is not as primary storage as here the data is being stored for the long term or we can say it's permanent storage.

6.2.1 RAM

RAM means random access memory which is used to access any temporary data and to get intermediate results for the usage of that information. It is also known as temporary memory because the data will be stored only till the computer system is on, if it's turned off the data will be lost.

6.2.2 ROM

ROM means read-only memory. This is also known as non-volatile memory as the information here is stored permanently until and unless it's deleted by the user.

6.3 Magnetic storage devices

6.3.1 Floppy disk

It is a type of storage device which is used in the personal computer on a personal basis. Floppy disk is generally used with plastic and is made secure by using protective cases.

6.3.2 Hard disk

It's a hard disc drive (HDD) that uses magnetic storage to store and retrieve data. It's a non-volatile device that stores data that could be changed or deleted an infinite number of times.

6.3.3 Magnetic disk

It's a card that stores data by changing or reorganizing the magnetism of microscopic metal magnetic nanoparticles on the card's band. A swipe card is another name for it.

6.4 Flash memory devices

6.4.1 Pen drive

This is also called a USB drive since it has flash memory and a built-in USB interface. These devices can be immediately connected to our desktops and laptops, allowing us to read data into them even more quickly and efficiently.

6.4.2 SSD

It refers to Solid State Drive, a type of mass storage technology similar to hard disc drives. It is much more resilient than hard drives as it does not require visual discs.

6.4.3 Sd card

A Contactless Smart Card is what it's called. It is commonly used for storing greater information on electronic devices such as phones, cameras, and so on.

6.4.4 Memory card

It's commonly found in digital cameras, printers, gaming consoles, and other electronic devices. It may be used to carry lots of data and comes in a variety of sizes. A memory card reader is required to use a storage device on a computer.

6.5 Optical storage devices

6.5.1 CD

Compact Disc is the name for it. It has data-storage channels and sections on its surface. It has a round form and is composed of polycarbonate plastic.

6.5.2 DVD

Digital Versatile Disc is the name given to it. DVDs are data storage discs that are round and flat. It is available in two distinct sizes: 4.7Gigabyte solitary discs and 8.5Gigabyte dual discs.

6.5.3 Cloud and virtual storage

Digital or cloud storage systems have replaced secondary memory in recent years. We can keep our documents and other items on the cloud for just as much as we subscribe to cloud storage. Many corporations, namely amazon, google, Microsoft, and others, offer cloud services.

6.6 Central Processing Unit

The main part of the computer that performs the bulk of data-processing operations is called the central processing unit and is referred to as the CPU.

The CPU is made up of three major parts,

1. The register set stores intermediate data used during the execution of the instructions.

2. The arithmetic logic unit (ALU) performs the required microoperations for executing the instructions.

3. The control unit supervises the transfer of information among the registers and instructs the ALU as to which operation to perform

6.6.1. Stack Organization

A stack or last-in first-out (LIFO) is useful feature that is included in the CPU of most computers.A stack is a storage device that stores information in such a manner that the item stored last is the first item retrieved.

1. The operation of a stack can be compared to a stack of trays. The last tray placed on top of the stack is the first to be taken off.

2. In the computer stack is a memory unit with an address register that can count the address only.
3. The register that holds the address for the stack is called a stack pointer (SP). It always points at the top item in the stack.
4. The two operations that are performed on stack are the insertion and deletion.
5. The operation of insertion is called PUSH.

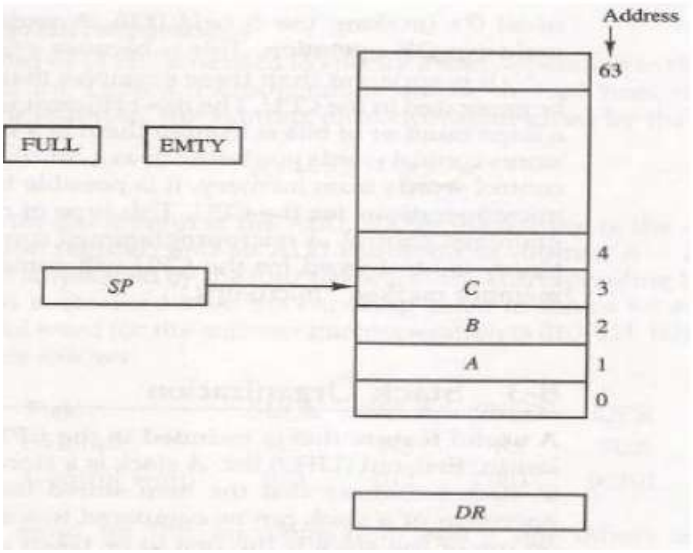
The operation of deletion is called POP.

These operations are simulated by incrementing and decrementing the stack pointer register (SP)

6.6.2 Register Stack

A stack can be placed in a portion of a large memory or it can be organized as a collection of a finite number of memory words or registers.

The below figure shows the organization of a 64-word register stack.



BLOCK DIAGRAM OF 64 WORD STACK

The stack pointer register SP contains a binary number whose value is equal to the address of the word is currently on top of the stack. Three items are placed in the stack: A, B, C, in that order.
In above figure C is on top of the stack so that the content of SP is 3.

For removing the top item, the stack is popped by reading the memory word at address 3 and decrementing the content of stack SP.

Now the top of the stack is B, so that the content of SP is 2.
Similarly for inserting the new item, the stack is pushed by incrementing SP and writing a word in the nexthigher location in the stack.

In a 64-word stack, the stack pointer contains 6 bits because 26 = 64.
Since SP has only six bits, it cannot exceed a number greater than 63 (111111 in binary).

When 63 is incremented by 1, the result is 0 since 111111 + 1. = 1000000 in binary, but SP can accommodate only the six least significant bits.

Then the one-bit register FULL is set to 1, when the stack is full.
Similarly when 000000 is decremented by 1, the result is 111111, and then the one-bit register EMTY is set 1 when the stack is empty of items.

DR is the data register that holds the binary data to be written into or read out of the stack.

Push

Initially, SP is cleared to 0, EMTY is set to 1, and FULL is cleared to 0, so that SP points to the word at address 0 and the stack is marked empty and not full.
If the stack is not full (if FULL = 0), a new item is inserted with a push operation.

The push operation is implemented with the following sequence of microoperations:

$SP \leftarrow SP + 1$	Increment stack pointer
$M[SP] \leftarrow DR$	Write item on top of the stack
If ($SP = 0$) then ($FULL \leftarrow 1$)	Check if stack is full
$EMTY \leftarrow 0$	Mark the stack not empty

The stack pointer is incremented so that it points to the address of next-higher word. ¬ A memory write operation inserts the word from DR the top of the stack.

1. The first item stored in the stack is at address 1.
2. The last item is stored at address 0.
3. If SP reaches 0, the stack is full of items, so FULL is to 1.
4. This condition is reached if the top item prior to the last push way location 63 and, after incrementing SP, the last item is stored in location 0.
5. Once an item is stored in location 0, there are no more empty registers in the stack, so the EMTY is cleared to 0.

POP

A new item is deleted from the stack if the stack is not empty (if EMTY = 0).
The pop operation consists of the following sequence of min operations:

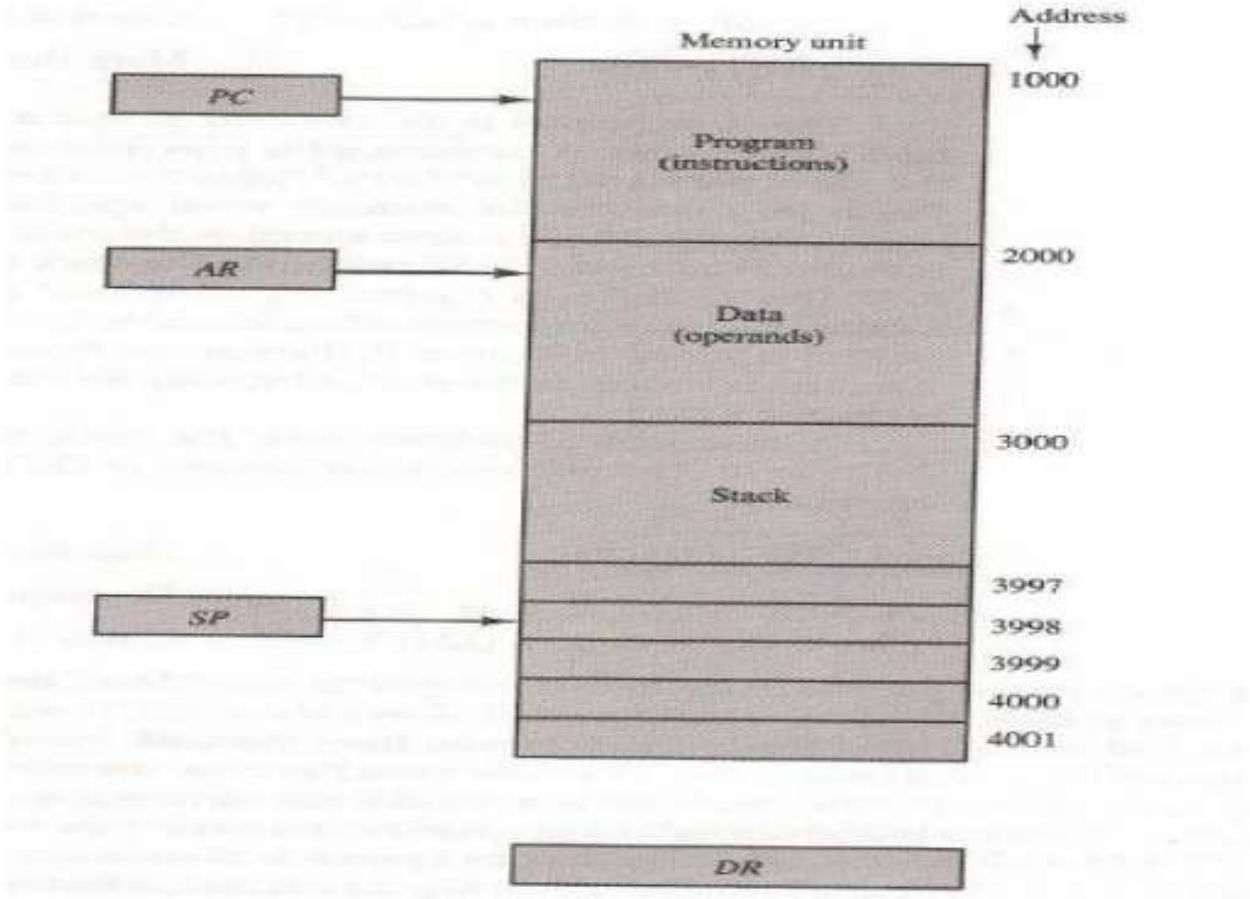
$DR \leftarrow M[SP]$	Read item from the top of stack
$SP \leftarrow SP - 1$	Decrement stack pointer
If ($SP = 0$) then ($EMTY \leftarrow 1$)	Check if stack is empty
$FULL \leftarrow 0$	Mark the stack not full

6.6.3 Memory Stack

In the above discussion a stack can exist as a stand-alone unit. But in the CPU implementation of a stack is done by assigning a portion of memory to a stack operation and using a processor register as stack pointer.

The below figure shows a portion computer memory partitioned into three segments:

program, data, and stack.



Computer memory with program, data stack segment

1. The program counter PC points at the address of the next instruction in program.
2. The address register AR points at an array of data.
3. The stack pointer SP points at the top of the stack.
4. The three registers are connected to a common address bus, and either one can provide an address formemory.

PC is used during the fetch phase to read an instruction.

1. AR is used during the exec phase to read an operand.
2. SP is used to push or pop items into or from stack.

Thus the first item stored in the stack is at address 4000, the second item is stored at address 3999, and the lastaddress that can be used for the stack is 3000.
No provisions are available for stack limit checks.
The items in the stack communicate with a data register DR. A new item is inserted with the push operation as follows:

$$SP \leftarrow SP-1$$

$$M[SP] \leftarrow DR$$

The stack pointer is decremented so that it points at the address of the next word.

A memory write operation inserts the word from DR into the top of stack. A new item

is deleted with a popoperation as follows:

DR ← M [SP]
SP← SP+1

The top item is read from the stack into DR. The stack pointer is then decremented to point at the next item inthe stack.

Most computers do not provide hardware to check for stack overflow (full stack) or underflow (empty stack).

1. The stack limits can be checked by using processor registers:
2. one to hold the upper limit (3000 in this case)
3. Other to hold the lower limit (4001 in this case).

After a push operation, SP compared with the upper-limit register and after a pop operation, SP is a comparedwith the lower-limit register.
The two microoperations needed for either the push or pop are
(1) An access to memory through SP
(2) Updating SP.

The advantage of a memory stack is that the CPU can refer to it without having specify an address, since theaddress is always available and automatically updated in the stack pointer.

Reverse Polish Notation:

A stack organization is very effective for evaluating arithmetic expressions.
The common arithmetic expressions are written in infix notation, with each operator written between theoperands.

Consider the simple arithmetic expression.
A*B+C*D

For evaluating the above expression it is necessary to compute the product A*B, store this product result whilecomputing C*D, and then sum the two products.

For doing this type of infix notation, it is necessary to scan back and forth along the expression to determine thenext operation to be performed.
The Polish mathematician Lukasiewicz showed that arithmetic expression can be represented in prefix notation.

This representation, often referred to as Polish notation, places the operator before the operands. So it is alsocalled as prefix notation.

The Postfix notation, referred to as reverse Polish notation (RPN), places the operator after the operands.

The following examples demonstrate the three representationsEg: A+B -----> Infix notation
AB ------> Prefix or Polish notation
AB+ -------> Post or reverse Polish notation

The reverse Polish notation is in a form suitable for stack manipulation. The expression
A*B+C*D

Is written in reverse polish notation asAB* CD* +
And it is evaluated as follows

Scan the expression from left to right.

When operator is reached, perform the operation with the two operands found on the left side of theoperator.

Remove the two operands and the operator and replace them by the number obtained from the resultof the operation.

Continue to scan the expression and repeat the procedure for every operation encountered until thereare no more operators.

For the expression above it find the operator * after A and B. So it perform the operation A*B and replace A, B and * with the result.

The next operator is a * and it previous two operands are C and D, so it perform the operation C*D and placesthe result in places C, D and *.

The next operator is + and the two operands to be added are the two products, so we add the two quantities toobtain the result.

The conversion from infix notation to reverse Polish notation must take into consideration the operationalhierarchy adopted for infix notation.

This hierarchy dictates that we first perform all arithmetic inside inner parentheses, then inside outerparentheses, and do multiplication and division operations before addition and subtraction operations.

6.7 Evaluation of Arithmetic Expressions:

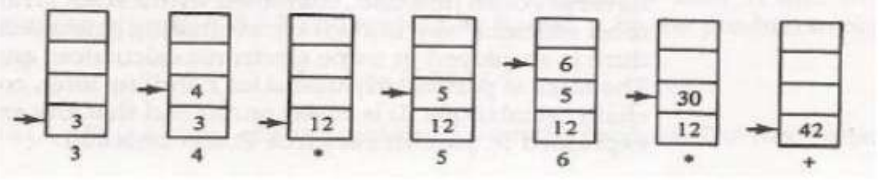
Reverse Polish notation, combined with a stack arrangement of registers, is the most efficient way known forevaluating arithmetic expressions.
This procedure is employed in some electronic calculators and also in some computer.

The following numerical example may clarify this procedure. Consider the arithmetic expression

(3*4) + (5*6)
In reverse polish notation, it is expressed as
34 * 56* +

Now consider the stack operations shown in

Figure 8-5 Stack operations to evaluate 3 • 4 + 5 • 6.



Each box represents one stack operation and the arrow always points to the top of the stack.

Scanning the expression from left to right, we encounter two operands.

First the number 3 is pushed into the stack, then the number 4.
The next symbol is the multiplication operator *.

This causes a multiplication of the two top most items the stack.
The stack is then popped and the product is placed on top of the stack, replacing the two original operands.

Next we encounter the two operands 5 and 6, so they are pushed into the stack.
The stack operation results from the next * replaces these two numbers by their product.
The last operation causes an arithmetic addition of the two topmost numbers in the stack to produce the final result of 42.

Instruction Formats:

The format of an instruction is usually depicted in a rectangular box symbolizing the bits of the instruction asthey appear in memory words or in a control register.

The bits of the instruction are divided into groups called fields.
The most common fields found in instruction formats are:

1. An operation code field that specifies the operation to be perform
2. An address field that designates a memory address or a processor register.
3. A mode field that specifies the way the operand or the effective address is determined.

Computers may have instructions of several different lengths containing varying number of addresses.
The number of address fields in the instruct format of a computer depends on the internal organization of its registers.

Most computers fall into one of three types of CPU organizations:

6.8 Types of CPU Organization

1. Single accumulator organization.
2. General register organization.
3. Stack organization.

6.8.1 Single Accumulator Organization:

1. In an accumulator type organization all the operations are performed with an implied accumulator register.
2. The instruction format in this type of computer uses one address field.
3. For example, the instruction that specifies an arithmetic addition defined by an assembly language
4. instruction asADD X
5. Where X is the address of the operand. The ADD instruction in this case results in the operation AC AC+M[X]. AC is the accumulator register and M[X] symbolizes the memory word located at address X.

6.8.2 General register organization

The instruction format in this type of computer needs three register address fields. Thus the instruction for an arithmetic addition may be written in an assembly language asADD R1, R2, R3to denote the operation R1 R2+ R3. The number of address fields in the instruction can bereduced from three to two if the destination register is the same as one of the source registers.

Thus the instruction ADD R1, R2 would denote the operation R1 R1 + R2. Only register addresses for R1and R2 need be specified in this instruction.

1. General register-type computers employ two or three address fields in their instruction format.
2. Each address field may specify a processor register or a memory word.
3. An instruction symbolized by ADD R1, X would specify the operation R1 R1 + M[X].

It has two address fields, one for register R1 and the other for the memory address X.

6.8.3 Stack organization

The stack-organized CPU has PUSH and POP instructions which require an address field.
Thus the instruction PUSH X will push the word at address X to the top of the stack.

The stack pointer is updated automatically.

1. Operation-type instructions do not need an address field in stack-organized computers.
2. This is because the operation is performed on the two items that are on top of the stack.
3. The instruction ADD in a stack computer consists of an operation code only with no address field.
4. This operation has the effect of popping the two top numbers from the stack, adding the numbers, andpushing the sum into the stack.
5. There is no need to specify operands with an address field since all operands are implied to be in the stack.

Most computers fall into one of the three types of organizations

1. Some computers combine features from more than one organizational structure.
2. The influence of the number of addresses on computer programs, we will evaluate the arithmetic statementX= (A+B) * (C+D
3. Using zero, one, two, or three address instructions and using the symbols ADD, SUB, MUL and DIV for fourarithmetic operations; MOV for the transfer type operations; and LOAD and STORE for transfer to and frommemory and AC register.
4. Assuming that the operands are in memory addresses A, B, C, and D and the result must be stored in memory address X and also the CPU has general purpose registers R1, R2, R3 and R4.

Three Address Instructions:

Three-address instruction formats can use each address field to specify either a processor register or amemory operand.

The program assembly language that evaluates X = (A+B) * (C+D) is shown below, together withcomments that explain the register transfer operation of each instruction.

```
ADD   R1, A, B    R1←M[A] + M[B]
ADD   R2, C, D    R2←M[C] + M[D]
MUL   X, R1, R2   M[X]←R1*R2
```

The symbol M [A] denotes the operand at memory address symbolized by A.

The advantage of the three-address format is that it results in short programs when evaluating arithmetic expressions.

The disadvantage is that the binary-coded instructions require too many bits to specify three addresses.

Two Address Instructions:

Two-address instructions formats use each address field can specify either a processor register ormemory word.

The program to evaluate X = (A+B) * (C+D) is as follows

```
MOV   R1, A     R1←M[A]
ADD   R1, B     R1←R1 + M[B]
MOV   R2, C     R2←M[C]
ADD   R2, D     R2←R2 + M[D]
MUL   R1,R2     R1←R1*R2
MOV   X, R1     M[X]←R1
```

The MOV instruction moves or transfers the operands to and from memory and processor registers.

The first symbol listed in an instruction is assumed be both a source and the destination where theresult of the operation transferred.

One Address Instructions:

One-address instructions use an implied accumulator (AC) register for all data manipulation.For multiplication and division there is a need for a second register. But for the basic discussion we willneglect the second register and assume that the AC contains the result of all operations.

The program to evaluate X=(A+B) * (C+D) is

```
LOAD    A    AC←M[A]
ADD     B    AC←AC + M[B]
STORE   T    M[T]←AC
LOAD    C    AC←M[C]
ADD     D    AC←AC + M[D]
MUL     T    AC←AC*M[T]
STORE   X    M[X]←AC
```

All operations are done between the AC register and a memory operand.
T is the address of a temporary memory location required for storing the intermediate result.

Zero Address Instructions:

A stack-organized computer does not use an address field for the instructions ADD

and MUL.The PUSH and POP instructions, however, need an address field to specify the operand thatcommunicates with the stack.The following program shows how X = (A+B) * (C+D) will be written for a stack-organizedcomputer.

(TOS stands for top of stack).

```
PUSH    A    TOS ← A
PUSH    B    TOS ← B
ADD          TOS ← (A + B)
PUSH    C    TOS ← C
PUSH    D    TOS ← D
ADD          TOS ← (C + D)
MUL          TOS ← (C + D) * (A + B)
POP     X    M[X] ← TOS
```

To evaluate arithmetic expressions in a stack computer, it is necessary to convert the expression intoreverse Polish notation.

The name "zero-address" is given to this type of computer because of the absence of an address field inthe computational instructions.

RISC Instructions

The instruction set of a typical RISC processor is use only load and store instructions for communicatingbetween memory and CPU.

All other instructions are executed within the registers of CPU without referring to memory. LOAD and STORE instructions that have one memory and one register address, and computational typeinstructions that have three addresses with all three specifying processor registers.

The following is a program to evaluate X=(A+B)*(C+D)

```
LOAD    R1, A          R1 ← M[A]
LOAD    R2, B          R2 ← M[B]
LOAD    R3, C          R3 ← M[C]
LOAD    R4, D          R4 ← M[D]
ADD     R1, R1, R2     R1 ← R1 + R2
ADD     R3, R3, R2     R3 ← R3 + R4
MUL     R1, R1, R3     R1 ← R1 * R3
STORE   X, R1          M[X] ← R1
```

1. The load instructions transfer the operands from memory to CPU register.
2. The add and multiply operations are executed with data in the register without accessing memory.
3. The result of the computations is then stored memory with a store in instruction.

6.9 Computer Configuration

CONFIGURATION is the way a system is set up or the assortment of components that make up the system. Configuration can refer to either hardware or software, or the combination of both.

CMOS – It is the term usually used to describe the small amount of memory on a computer motherboard that stores the BIOS settings.

6.9.1 Basic Input/Output System (BIOS)

The Basic Input Output System, usually referred to as BIOS, is software stored on a small memory chip on the motherboard. BIOS instructs the computer on how to perform several basic functions such as booting and keyboard control. BIOS is also used to identify and configure the hardware in a computer such as the hard drive, optical drive, CPU, memory, etc.

- The BIOS is accessed and configured through the BIOS Setup Utility. The BIOS Setup Utility is, for all reasonable purposes, the BIOS itself. All available options in BIOS are configurable via the BIOS Setup Utility. The BIOS Setup Utility is accessed in various ways depending on your computer or motherboard make and model.
- BIOS access and configuration on PC systems is independent of any operating system because the BIOS is part of the motherboard hardware. It doesn't matter if a computer is running Windows 7, Windows Vista, Windows XP, Linux, Unix, or no operating system at all – BIOS functions outside of the operating system environment and is no way dependent upon it.
- BIOS contain several hardware configuration options that can be changed through the setup utility. Saving these changes and restarting the computer applies the changes to the BIOS and alters the way BIOS instructs the hardware to function. The following list shows the things you can do in most BIOS systems:

1. Change the Boot Order
2. Load BIOS Setup Defaults
3. Remove a BIOS Password
4. Create a BIOS Password
5. Change the Date and Time
6. Change Floppy Drive Settings
7. Change Hard Drive Settings
8. Change CD/DVD/BD Drive Settings
9. View Amount of Memory Installed
10. Change the Boot Up NumLock Status
11. Enable or Disable the Computer Logo
12. Enable or Disable the Quick Power OnSelf Test (POST)
13. Enable or Disable the CPU Internal Cache
14. Enable or Disable the Caching of BIOS
15. Change CPU Settings
16. Change Memory Settings
17. Change System Voltages

6.10 Conclusion

A storage unit is a part of the computer system which is employed to store the information and instructions to be processed. A storage device is an integral part of the computer hardware which stores information/data to process the result of any computational work. Without a storage device, a computer would not be able to run or even boot up. Or in other words, we can say that a storage device is hardware that is used for storing, porting, or extracting data files. The storage devices are getting smaller day by day with changing technology but can hold tons of data at a time. Everyone has their data or some information to store and storage devices are the one that satisfies this need of people and serve many purposes.

6.11 Key words

RAM means random access memory which is used to access any temporary data and to get intermediate results for the usage of that information

ROM means read-only memory. This is also known as non-volatile memory as the information here is stored permanently until and unless it's deleted by the user.

Magnetic disk- It's a card that stores data by changing or re-organising the magnetism of microscopic metal magnetic nano particles on the card's band.

Compact Disc is the name for it. It has data-storage channels and sections on its surface. It has a round form and is composed of polycarbonate plastic.

Configuration is the way a system is set up or the assortment of components that make up the system. Configuration can refer to either hardware or software, or the combination of both.

Input / Output System (BIOS)- The Basic Input Output System, usually referred to as BIOS, is software stored on a small memory chip on the motherboard.

6.12 Self Assessment Questions

1. Discuss the Types of Computer Storage
2. Explain the Magnetic Storage Devices
3. Briefly describe the Central Processing Unit
4. Outline the Computer Configuration system

6.13 Suggested Readings

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LESSON- 7

BINARY DATA REPRESENTATION & COMPUTER CONFIGURATION

Objectives of the Lesson

- ✓ To Understand the Number systems for Computer
- ✓ To Study the Decimal number system
- ✓ To learn the Octal Number system and binary Number system
- ✓ To Outline the Conversions between Numbers 2n and 2m
- ✓ To focus on the Conversion of Rational Numbers

Structure

7.1 Introduction

Binary Data Representation

Bit: smallest unit of information yes / no, on / off, L / 0, 1 / 0, 5V / 0V

Byte: group of 8 bits --> 28 = 256 different states

Word: the number of bits (word length) which can be processed by a computer in a singlestep (e.g., 32 or 64) -> machine dependent
The word size in any given computer is fixed.

Example: 16-bit word
⇒ every word (memory location) can hold a 16-bit pattern, with each bit either 0 or 1.

How many distinct patterns are there in a 16-bit word?
• Each bit has 2 possible values: 0 or 1

⇒ 1 bit has 2 distinct patterns: 0, 1

• With 2 bits, each position has 2 possible values: 00, 01, 10, 11

⇒ 22 = 4 distinct bit patterns

• With 3 bits, again each position can be either 0 or 1:
000 100
001 101
010 110
011 111
⇒ 23 = 8 distinct bit patterns

• In general, for n bits (a word of length n) we have 2n distinct bitPatterns

7.2 Important Number Systems for Computers

Number System Basics
• Number systems, as we use them, consist of
- a basic set of digits (or letters); example:
- a base (how many digits); example:
• A number is a linear sequence of digits.
• The value of a digit at a specific position depends on its "assigned meaning" and on its position.
• The value of a number is the sum of these values.
Number: with word length Value: Z Z = { } 012 ,,, , … 9 B Z = B Z = = 10 N NB dn – 1dn – 2…d1d0 = n

$$\text{Value: } N_B = \sum_{i=0}^{n-1} d_i \cdot B^i = d_{n-1}B^{n-1} + d_{n-2}B^{n-2} + \ldots + d_1 B^1 + d_0 B^0$$

Name	Base	Digits
dual binary	2	0, 1
octal	8	0, 1, 2, 3, 4, 5, 6, 7
decimal	10	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
hexadecimal sedecimal	16	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

7.3 Decimal Number System

• Each position to the left of a digit increases by a power of 10.
• Each position to the right of a digit decreases by a power of 10.
Example:
4769210 = 2 · 100 +
9 · 101 +
6 · 102 +
7 · 103 +
4 · 104
= 2 + 90 + 600 + 7000 + 40000

7.4 Binary Number System

• Each position to the left of a digit increases by a power of 2.
• Each position to the right of a digit decreases by a power of 2.
Example:
101110012 = 1 · 20 +
0 · 21 +
0 · 22 +
1 · 23 +
1 · 24 +
1 · 25 +
0 · 26 +
1 · 27 = 1 + 8 + 16 + 32 + 128 = 18510

Decimal	Dual	Decimal	Dual
0	00 000	16	10 000
1	00 001	17	10 001
2	00 010	18	10 010
3	00 011	19	10 011
4	00 100	20	10 100
5	00 101	21	10 101
6	00 110	22	10 110
7	00 111	23	10 111
8	01 000	24	11 000
9	01 001	25	11 001
10	01 010	26	11 010
11	01 011	27	11 011
12	01 100	28	11 100
13	01 101	29	11 101
14	01 110	30	11 110
15	01 111	31	11 111

7.5 Octal Number System
• Each position to the left of a digit increases by a power of 8.
• Each position to the right of a digit decreases by a power of 8.
Example:
124038 = 3 · 80 +
0 · 81 +
4 · 82 +
2 · 83 +
1 · 84
= 3 · 1 + 0 · 8 + 4 · 64 + 2 · 512 + 1 · 4096
= 537910

Counting in Octal

Decimal	Octal	Decimal	Octal
0	0 0	16	2 0
1	0 1	17	2 1
2	0 2	18	2 2
3	0 3	19	2 3
4	0 4	20	2 4
5	0 5	21	2 5
6	0 6	22	2 6
7	0 7	23	2 7
8	1 0	24	3 0
9	1 1	25	3 1
10	1 2	26	3 2
11	1 3	27	3 3
12	1 4	28	3 4
13	1 5	29	3 5
14	1 6	30	3 6
15	1 7	31	3 7

7.6 Hexadecimal Number System

Each position to the left of a digit increases by a power of 16.
Each position to the right of a digit decreases by a power of 16.
Example:
FB40A16 = 10 · 160 +
0 · 161 +
4 · 162 +
11 · 163 +
15 · 164
= 10 · 1 + 0 · 16 + 4 · 256 + 11 · 4096 + 15 · 65536
= 1,029,13010

Counting in Hexadecimal

Decimal	Hexadecimal	Decimal	Hexadecimal
0	0 0	16	1 0
1	0 1	17	1 1
2	0 2	18	1 2
3	0 3	19	1 3
4	0 4	20	1 4
5	0 5	21	1 5
6	0 6	22	1 6
7	0 7	23	1 7
8	0 8	24	1 8
9	0 9	25	1 9
10	0 A	26	1 A
11	0 B	27	1 B
12	0 C	28	1 C
13	0 D	29	1 D
14	0 E	30	1 E
15	0 F	31	1 F

Comparison of Number Systems

Decimal	Dual	Octal	Hexadecimal	Decimal	Dual	Octal	Hexadecimal
0	00 000	0 0	0 0	16	10 000	2 0	1 0
1	00 001	0 1	0 1	17	10 001	2 1	1 1
2	00 010	0 2	0 2	18	10 010	2 2	1 2
3	00 011	0 3	0 3	19	10 011	2 3	1 3
4	00 100	0 4	0 4	20	10 100	2 4	1 4
5	00 101	0 5	0 5	21	10 101	2 5	1 5
6	00 110	0 6	0 6	22	10 110	2 6	1 6
7	00 111	0 7	0 7	23	10 111	2 7	1 7
8	01 000	1 0	0 8	24	11 000	3 0	1 8
9	01 001	1 1	0 9	25	11 001	3 1	1 9
10	01 010	1 2	0 A	26	11 010	3 2	1 A
11	01 011	1 3	0 B	27	11 011	3 3	1 B
12	01 100	1 4	0 C	28	11 100	3 4	1 C
13	01 101	1 5	0 D	29	11 101	3 5	1 D
14	01 110	1 6	0 E	30	11 110	3 6	1 E
15	01 111	1 7	0 F	31	11 111	3 7	1 F

Powers of 2

N	2^N	N	2^N
0	1	17	131,072
1	2	18	262,144
2	4	19	524,288
3	8	20	1,048,576
4	16	21	2,097,152
5	32	22	4,194,304
6	64	23	8,388,608
7	128	24	16,777,216
8	256	25	33,554,432
9	512	26	67,108,864
10	1,024	27	134,217,728
11	2,048	28	268,435,456
12	4,096	29	536,870,912
13	8,192	30	1,073,741,824
14	16,384	31	2,147,483,648
15	32,768	32	4,294,967,296
16	65,536	33	8,589,934,592

7.7 Conversions Between Number Systems

Conversion of Natural Numbers

Base 10 ⇒ Base B Conversion

We use the method of iterated division to convert a number of base 10 into a number of base .

1. Divide the number by : whole number & remainder .
- Take as the next number to be divided by .
- Keep as the next left-most digit of the new number .
2. If is zero then STOP, else set and go to step 1.

Example: 102010 = ? 8

Number to be converted: ; target base

Step 1: 1020 : 8 = 127 Remainder: 4 127 · 8 = 1016

Step 2: 127 : 8 = 15 Remainder: 7 15 · 8 = 120

Step 3: 15 : 8 = 1 Remainder: 7 1 · 8 = 8

Step 4: 1 : 8 = 0 Remainder: 1

⇒ 102010 = 17748

7.8 Base B ⇒ Base 10 Conversion

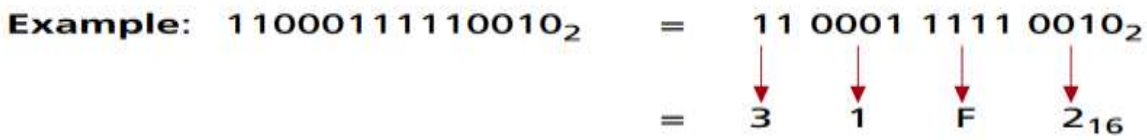
We use the method of iterated multiplication to convert a numberof base into a number of base 10.

We simply add the “contribution” of each digit.

Example: 1F216 = ?10
Number to be converted: ; target base
1F216 = 2 · 160 +
15 · 161 +
1 · 162
= 2 + 240 + 256
⇒ 1F216 = 4981

7.9 Conversions between Numbers 2n and 2m
• Conversion 2n ⇒ 21
n = 3: octal ⇒ dual:
Replace 1 octal digit by 3 binary digits.
Example: 3 5 78 = 011 101 1112
n = 4: hexadecimal ⇒ dual
Replace 1 hexadecimal digit by 4 binary digits.
Example: 1 F 216 = 0001 1111 00102
Conversion 21 ⇒ 2n n = 3: dual ⇒ octal: Replace 3 binary digits by 1 octal digit.

n = 4: hexadecimal ⇒ dual Replace 4 binary digits by 1 hexadecimal digit.



Conversion 2n ⇒ 2m 2n ⇒ 21 ⇒ 2m

7.10 Conversion of Rational Numbers
Note: An exact conversion of rational numbers ⇒ or ⇒is not always possible.
• We want: , where is a “sufficiently” small number.
Base B ⇒ Base 10 Conversion
Example: 0.110012 = ?10
0.11001 = 1 · 2-1 + 1 · 2-2 + 0 · 2-3 + 0 · 2-4 + 1 · 2-5
= 1 · 0.5 + 1 · 0.25 + 0 · 0.125 + 0 · 0.0625 + 1 · 0.03125
= 0.5 + 0.25 + 0.03125
= 0.7812510
Base 10 ⇒ Base B Conversion Example: 0.1910 = ?2 with k = 9 bit precision

Step i	N	Operation	R	$z_{(-i)}$
1	0.19	$0.19 \cdot 2 = 0.38$	0.38	0
2	0.38	$0.38 \cdot 2 = 0.76$	0.76	0
3	0.76	$0.76 \cdot 2 = 1.52$	0.52	1
4	0.52	$0.52 \cdot 2 = 1.04$	0.04	1
5	0.04	$0.04 \cdot 2 = 0.08$	0.08	0
6	0.08	$0.08 \cdot 2 = 0.16$	0.16	0
7	0.16	$0.16 \cdot 2 = 0.32$	0.32	0
8	0.32	$0.32 \cdot 2 = 0.64$	0.64	0
9	0.64	$0.64 \cdot 2 = 1.28$	0.28	1

7.11 Binary Logic

Logical AND ($x \wedge y$)

AND	0	1
0	0	0
1	0	1

Logical OR ($x \vee y$)

OR	0	1
0	0	1
1	1	1

Logical NOT ($\neg x$, negation)

x	$\neg x$
0	1
1	0

Logical XOR (exclusive OR)

XOR	0	1
0	0	1
1	1	0

Logical NAND (negated AND)

NAND	0	1
0	1	1
1	1	0

AND

```
11001010 01000111 11110000
00110101 01110010 10101010
00000000 01000010 10100000
```

NAND

```
11001010 01000111 11110000
00110101 01110010 10101010
11111111 10111101 01011111
```

OR

```
11001010 01000111 11110000
00110101 01110010 10101010
11111111 01110111 11111010
```

XOR

```
11001010 01000111 11110000
00110101 01110010 10101010
```

Binary Arithmetic Elementary Rules for addition, subtraction, and multiplication

	Operation	Result	Carry
Addition	0 + 0	0	0
	0 + 1	1	0
	1 + 0	1	0
	1 + 1	0	1
Subtraction	0 - 0	0	0
	0 - 1	1	1
	1 - 0	1	0
	1 - 1	0	0
Multiplication	0 · 0	0	0
	0 · 1	0	0
	1 · 0	0	0
	1 · 1	1	0

Examples:

Addition:

```
      1 0 1 0
+     1 0 1 1
-------------
carry: 1   1
+    1   1
-------------
     1 0 1 0 1
```

Subtraction:

```
      1 1 0 1
-     1 0 1 0
-------------
carry:     1
-        1
-------------
       0 0 1 1
```

$$\begin{array}{r} 10_{10} \\ + \quad 11_{10} \\ \hline 21_{10} \end{array}$$

$$\begin{array}{r} 13_{10} \\ - \quad 10_{10} \\ \hline 3_{10} \end{array}$$

Examples:

Addition:

```
      1 0 1 0
+     1 0 1 1
-------------
carry: 1   1
+    1   1
-------------
     1 0 1 0 1
```

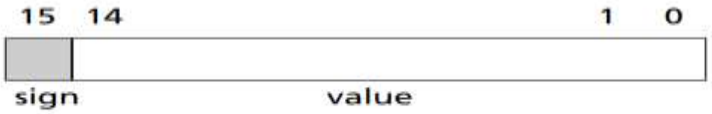
Subtraction:

```
      1 1 0 1
-     1 0 1 0
-------------
carry:     1
-        1
-------------
       0 0 1 1
```

$$\begin{array}{r} 10_{10} \\ + \quad 11_{10} \\ \hline 21_{10} \end{array}$$

$$\begin{array}{r} 13_{10} \\ - \quad 10_{10} \\ \hline 3_{10} \end{array}$$

Negative Numbers and Complements Integer Numbers: A possible representation



Number = sign & value

- sign = 0 ⇒ +, positive number
- sign = 1 ⇒ -, negative number

Range of integer numbers for *n* bits: $-2^{n-1}+1 \ldots 2^{n-1}-1$

Example (1): n = 3

Sign	Value	Number
0	0 0	0
0	0 1	1
0	1 0	2
0	1 1	3
1	0 0	? ← Negative zero?
1	0 1	- 1
1	1 0	- 2
1	1 1	- 3

Range: - 23-1+1 … 23-1-1
= - 22+1 … 22-1
= - 4 + 1 … 4 -1 = -3 ... +3
Problems of Signed Number Representation
• Given 2 binary numbers: one positive, one negative
0 0 1 1 0 0 (base 2) 12 (base 10)
+ 1 0 1 1 1 1 -15
_____ _____
1 1 1 0 1 1 (= -2710) -3
• "1-1": 1 - 1 = 1 + (-1) = 0 ?
0 0 0 1 0 0 1
+ 1 0 0 1 - 0 0 1
_____ _____
1 0 1 0 (= -210) 0 0 0
Clearly this won´t work!
1-Complement ((B-1)-Complement)
We represent negative numbers by negating the positive

representation of the number (and vice versa):
• any 1 is changed to a 0
• any 0 is changed to a 1

Example:

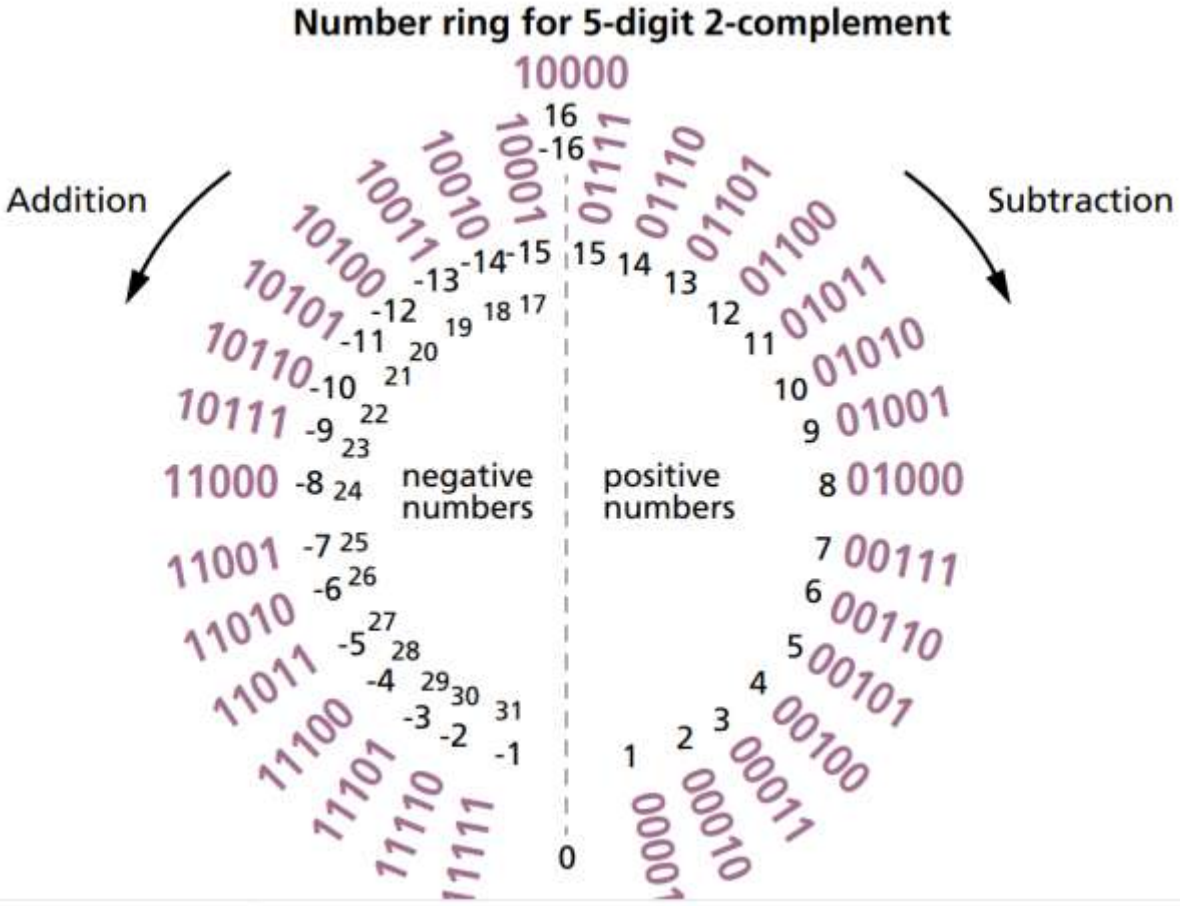
Binary	Decimal	One´s Complement	Decimal
0 1001	9	1 0110	- 9
1 1001	-6	0 0110	+ 6
0 0000	0	1 1111	-15
0 1111	15	1 0000	?

Problem!

2-Complement (B-Complement)
• Positive numbers are represented as usual.
• Negative numbers are created by
- negating the positive value and - adding one (this avoids the negative zero).

Examples:

Binary	Decimal	Two´s Complement	Decimal
0 1001	9	1 0110 + 1 = 1 0111	-9
0 1101	3	1 0010 + 1 = 1 0011	-3
0 0000	0	1 1111 + 1 = 0 0000	0
0 1111	15	1 0000 + 1 = 1 0001	-15
1 1111	-1	¬(1 1111 - 1) = ¬(1 1110) = 0 0001	1
1 0110	-10	0 1010	10



With the 2-complement, subtractions can be performed as simple additions: Example: 5 digit precision, base 10

	Example 1	*Example 2*
B = 10	$14_{10} - 7_{10}$	$9_{10} - 13_{10}$
Complement	7: 00111 $(-7)_{B-1}$: 11000 + 1 $(-7)_B$: 11001	13: 01101 $(-13)_{B-1}$: 10010 + 1 $(-13)_B$: 10011
Addition	14: 01110 $+(-7)_B$: + 11001 7: 1 00111	9: 01001 $+(-13)_B$: + 10011 -4: 11100

7.12 Floating Point Numbers

Mantissa and Exponent

Recall the general form of numbers expressed in scientific notation:

• 3.14159265358979323846264338327950288419 7

• 6.02 x 1023
Printed out by a computer these numbers usually look like this:
• 3.1415e0
• 6.02e23
This representation saves space and reduces redundancy.

Floating Point Arithmetic's

Example: $0.740 \cdot 10^5 + 0.843 \cdot 10^3$

Operands	Compare Exponents	Adjust Exponents and Mantissae
$0.740 \cdot 10^5$ $0.843 \cdot 10^3$	$e_1 - e_2 = 2$	$0.740 \cdot 10^5$ $+ 0.008 \cdot 10^5$
		Result: $0.748 \cdot 10^5$

Addition:
1. Identify mantissae and exponents
2. Compare exponents
3. Adjust exponents if necessary
4. Adjust the shorter mantissa
5. Add mantissae
6. Normalize mantissa
7. Adjust exponent

Operands Compare Exponents Adjust Exponents and Mantissae
0.740 · 105
0.843 · 103 e1 - e2 = 2
0.740 · 105
+ 0.008 · 105
Result: 0.748 · 105

Example: Multiplication
• 1. Multiply of mantissae
• 2. Normalize mantissae
• 3. Adjust exponents
• 4. Add exponents

Example: $(0.792 \cdot 10^5) \cdot (0.116 \cdot 10^{-3})$

- **Step 1**: multiplication of the mantissae:

$0.792 \cdot 0.116 =$

$$\begin{aligned} & 0.792 \cdot 10^{-1} \\ + \quad & 0.792 \cdot 10^{-2} \\ + \quad & 4.752 \cdot 10^{-3} \end{aligned}$$

limited Precision

Note: Not all values can be represented!
Example:
- mantissa: 2 decimal digits
- exponent: 1 decimal digit
• Sample number: 74 · 102 = 7400
What is the next higher value?
75 · 102 = 7500
What about values 7400 < x < 7500?
⇒ They cannot be represented!!!
• Remedy, but not a perfect solution:
Increase the number of mantissa digits.

7.13 Representation of Characters
Usually: single characters are represented by 1 bytedifferent standards: ASCII1, EBCDIC2
Currently: internationalization with Unicodea single character is represented by 2 bytes

7.14 Summary

Data refers to the symbols that represent people, events, things, and ideas. Data can be a name, a number, the colors in a photograph, or the notes in a musical composition. Data Representation refers to the form in which data is stored, processed, and transmitted. Devices such as smartphones, iPods, and computers store data in digital formats that can be handled by electronic circuitry.

7.15 Key words
Bit- smallest unit of information yes / no, on / off, L / 0, 1 / 0, 5V / 0V

Byte- group of 8 bits --> 28 = 256 different states

Decimal Number System- Each position to the left of a digit increases by a power of 10.

Binary Number System- Each position to the left of a digit increases by a power of 2

Octal Number System- Each position to the left of a digit increases by a power of 8.

Hexadecimal Number System- Each position to the left of a digit increases by a power of 16

7.16 Self Assessment questions

1. Briefly Discuss the Number Systems for Computer
2. Examine the Decimal Number System?
3. Explain the Octal Number system and binary Number system
4. Outline the Conversion between between Numbers 2n and 2m
5. Discuss the Conversion of Rational Numbers

7.17 Suggested Readings

1. Jackfitz- Enz, John R.Mattoxll (2009), Predictive Analytics for HR, Wiley Publications
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4. Michael J.Kanuagh, Richard D.Johnson, (2016), HRIS Basics, Applications, Future Directions, Third Edition, Sage Publication India Ltd.
5. Gupta, Ashok Kumar (2018) Developing Human Resource Information System by, Daya Publishing House
6. Mohan Thite (2019) e-HRM: Digital Approaches, Directions & Applications Routledge Publications
7. Talya Bauer, Berrin Erdogan, David E. Caughlin, and Donald M. Truxillo (2019) Human Resource Management: People, Data, and Analytics Sage Publications Incorporation
8. Nicolas A. Valcik, Meghna Sabharwal, Teodoro J. Benavides (2021) Human Resources Information Systems A Guide for Public Administrators, Springer Publications.
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10. Dr.Mohammad Salameh Al(2022)- HRIS, Mahairah Book Rivers, Ist Edition

Dr.V.Tulasi Das

LESSON- 8

HARDWARE AND SOFTWARE

Objectives of lesson

- ✓ To study the CPU and its Components
- ✓ To Understand the Features of System Software
- ✓ To Learn Operating System
- ✓ To Discuss the System Models
- ✓ To Outline the system Design and Advantages

Structure

8.1 Introduction
8.2 CPU
- 8.2.1 Motherboard
- 8.2.2. Random Access Memory (RAM)
- 8.2.3. Video graphics array port
- 8.2.4. Power supply
- 8.2.5. Cooling fan
- 8.2.6. Hard drive
- 8.2.7. Monitor
- 8.2.8. Printer
- 8.2.9. Scanner
- 8.2.10. Computer mouse
- 8.2.11 Device Driver

8.3 Features of System software
8.4 Operating System:
- 8.4.1 Language Translators
- 8.4.2 Utility Software
- 8.4.3 Server
- 8.4.4 Utility Software
- 8.4.5 Windowing System
- 8.4.6 Application programs
- 8.4.7 Root-user processes
- 8.4.8 Assembler
- 8.4.9 Compiler
- 8.4.10 Interpreter
- 8.4.11 Editor
- 8.4.12 Loader
- 8.4.13 Linker
- 8.4.14 Debugger
- t8.4.15 Macro

8.5 System Models
- 8.5.1 Analysis Model
- 8.5.2. Design Model
- 8.5.3. Context Model
- 8.5.4. Behavioural Model
- 8.5.5 State Machine Model

8.1 Introduction

Computer hardware includes the physical parts of a computer. It refers to the computer system, especially those that form part of the central processing unit. Computer technicians should know the basic components of computer hardware and how to work with each part, including the motherboard, power supply, keyboard, mouse and monitor. In this article, we discuss what computer hardware is and the basic components of it along with how computer technicians can safely troubleshoot key parts of a personal computer.

Computer hardware includes the physical components of a computer. Personal computers (PCs) are electronic devices that use microchips to process information and may include desktop computers, laptops or tablets. Since a computer comprises many hardware components, they work together and depend on each other to function properly.

8.2 CPU

The CPU controls the computer processes and communicates with the other components of a personal computer. A computer's CPU may be one of the most complicated parts of the computer because of its intricacies. If a computer is experiencing CPU issues, a computer technician may start by checking the fan and cleaning out any dust or debris inside the machine. Another step a computer technician may complete is verifying that power supply cables work. A CPU will not function properly unless it receives a signal from the power supply.

8.2.1 Motherboard

The motherboard provides the structure for all other components and connects them, while also providing a way to distribute power, deliver information and connect to devices such as a printer or mouse. It controls how data transfers and what type of monitor or screen device to use, for example. It houses the CPU, memory and secondary storage devices such as hard drives.

The first thing that a computer technician may do to troubleshoot any motherboard issues is to take the PC apart and inspect all the connections for corrosion. They may also check the power supply and make sure the computer is receiving electricity.

8.2.2. Random Access Memory (RAM)

RAM is where data lives temporarily while it's being actively used by programs, such as when a user launches a computer application. A technician may know how to identify the type of RAM in a computer, how to replace it if it's defective and how to diagnose problems with copying data from one location in memory to another.

A technician should have knowledge about the different RAMs that are available and they may also know what types of errors might affect a computer's RAM operation. A technician may backup all computer files before fixing RAM to avoid losing critical programs and documents.

8.2.3. Video graphics array port

A video graphics array (VGA) port is a video input that is primarily used on PC monitors. Troubleshooting a VGA port could include verifying there isn't a loose connection, faulty cable or a broken monitor. Another task a computer technician may do is use compressed air to spray inside the VGA port to ensure it's free of dust.

8.2.4. Power supply

A power supply provides electricity to all components of a computer system. Typically, it's a power cord connected from the back of a PC tower into an electricity socket. A technician may troubleshoot the power supply by turning off the computer, unplugging and detaching the power supply cord or trying a new cord or outlet.

8.2.5. Cooling fan

Cooling fans are a computer's system to decrease overheating. Many computers have more than one cooling fan to help users who run their computer heavily, such as video streaming or gaming. A computer technician may need to fix a computer's cooling fan if a user notices their computer overheating. They may check for any damage to the blades and make sure that they are free from debris. Replacing computer fans can be a common troubleshooting solution for a technician.

8.2.6. Hard drive

Hard drives are data storage devices used to store files, programs or other information on a computer system. They use magnetically coated discs called hard disks that store digital representations of information. If a hard drive fails, a computer technician may suspect a corrupt hard drive. They may use data recovery software to repair the computer or may replace the hard drive.

8.2.7. Monitor

A computer monitor is an electronic device that displays what's what programs are running on your computer so a user can see. Some computer technicians may wear anti-static gloves when handling computer monitors to avoid static electricity. They may also troubleshoot monitor issues by disconnecting it from the computer and trying a new power cord.

8.2.8. Printer

This is a machine that produces copies of text or images on paper using ink. Popular printers include laser or inkjet and computer technicians may be skilled in troubleshooting issues across multiple brands and varieties. Computer technicians may service printers

including verifying power is running to the machine. They may also check to see if the paper tray is full and ready for printing. Technicians might replace or refill any ink cartridges and toner.

If the physical printer components are operating efficiently but the machine still isn't working, a technician will then troubleshoot software malfunctions that may occur in the communication between the computer and the printer. This requires more expertise to fix since it involves how the systems interact with each other rather than physical component failures on the printer itself.

8.2.9. Scanner

A scanner is a device that digitally copies an image or and makes it available as a file for access on a computer. If a scanner malfunctions, a computer technician may remove the cover and carefully check if it has any damage. If there are no visible issues, then they may check the power connection cable. Similar to a printer, there is computer software that connects the scanner to the computer, so a technician will also verify that the software is communicating to the scanner.

8.2.10. Computer mouse

A computer mouse can have a wire or is wireless and is an input device used to control a cursor on the computer monitor. A wired computer mouse has a cord that connects to a USB port on a computer while a wireless mouse has no physical connection with a computer system. Instead, a wireless mouse communicates using an adapter that is usually plugged into an available USB port and runs off its own batteries using Bluetooth technology.

Computer technicians may troubleshoot computer mouse issues by ensuring it's connected properly if it has a wire. If the mouse is wireless, a technician can look to see if they need batteries and that the wireless connection is working. Computer technicians can clean both wired and wireless with cloths to ensure there is no dust or debris on the sensor on the bottom of a mouse. If there is, the mouse may not operate correctly.

System software components are defined as the software system designed to operate the computer’s hardware; it provides a platform to run the application software and the basic functions for the computer usage. It protects the application programmer from the complexity and specific details of a particular computer being used, especially the memory and the hardware features. The component of the software is a self-contained system with one or more inputs and outputs channels; it has nothing to do without the input and does not serve anything without the output.

8.2.11 Device Driver

This is a system program used to control the number of devices attached o the computer; it acts as a translator between applications that the user and the hardware device used. A device driver tells the operating system how the device will work on certain commands the user generates. With the device’s help, driver computer hardware can interact with high-level system programs. For example, Wi-Fi driver, Bluetooth driver, etc.

8.3 Features of System software

System software or we can say programming alludes to the records and projects that make up your PC’s working system. System records incorporate libraries of capacities, system administrations, drivers for printers and other equipment, system inclinations, and

other design documents. The projects that are essential for the system programming incorporate constructing agents, compilers, recording the executive's instruments, system utilities, and debuggers.

The system programming is introduced on your PC when you introduce your working system. Dissimilar to application programs, in any case, system programming isn't intended to be controlled by the end client. For instance, while you may utilize your Web program each day, you most likely don't have a lot of need for a constructing agent program (except if, obviously, you are a software engineer).

Since system programming runs at the most fundamental level of your PC, it is classified as "low-level" programming. It produces the UI and permits the working system to connect with the equipment. Luckily, you don't need to stress over what the system programming is doing since it simply runs behind the scenes. It's ideal to think you are working at a "significant level" at any rate.

High Speed: System software or we can say programming should be just about as productive as conceivable to give a viable stage to more elevated level programming in the PC.

Hard to Manipulate: It frequently requires the utilization of a programming language, which is harder to use than a more instinctive one.

Low-level computer language: Basically system software is written in a low-level programming language that means the central processing unit, as well as different computer hardware, can be able to read all programs and commands.

Close to the system: The system software is directly connected to the different hardware and runs the application that we installed on the computer.

Versatile: System software or we can say programming should be communicated with both the particular equipment it runs on and the more elevated level application programming that is normally equipment freethinker and frequently has no immediate association with the equipment it runs on. The system software programming additionally should uphold different projects that rely upon it as they advance and change.

The system software is difficult to understand and design as well as it is less interactive.

Normally system software is used to run the basic function of a computer including the disk operating system.

Input/output system: After turning on the computer system the BIOS we can say that system software is able to handle data flow between the operating system and different hardware devices that we are connected to such as keyboard, mouse, printer, and scanner, etc.

Load Program or boot: In this type of system software we can load the operating system into the main memory we can say random access memory that is RAM.

Assembler: Basically assembler is used to convert the different computer instructions into a specified bit pattern that the processor is used to executing the different basic functions of

computer or operation as per user requirement.

Driver: Basically it is called a device driver and it is used to control all connected devices to the computer system such as a printer, sound, mouse, scanner, and keyboard as well as it is used to convert all I/O instructions into a device understandable format.

Moreover, system software programming can likewise incorporate system utilities, for example, the disk defragmenter and System Restore, and improvement apparatuses, like compilers and debuggers.

8.4 Operating System:

Basically, the operating system is the main part of any computer system or in other words we can say that it is the heart of the computer system. First, we need to install the operating system into a computer system then we are able to execute all basic functions smoothly as per requirement. That means we are able to operate the keyboard, mouse, monitor, and CPU, etc.

8.4.1 Language Translators

Language translator is used to converting the high-level programming language into machine-level language because the machine only understands the machine-level language. The high-level language means Java, C, C++, and Python. These are all examples of high-level programming languages. The user interacts with the computer only by using high-level computer programming language but the machine cannot be able to understand the high level so at that time we need to translate the high-level language into the machine-level programming language by using the compiler, interpreter, and assembler.

8.4.2 Utility Software

Utility programming is a sort of system software or we can say that system programming which goes about as an interface between system programming and application programming. These are those projects which are explicitly intended for some specific reason like upkeep of the PC or analyze any mistake in the PC. By and large, these are outsider devices that show up with the working system software. So this is an important feature we discussed here and it is an important part of any interaction between the application and computer.

8.4.3 Server

It is a program; it works like a socket listener in a computer operating system. A server is a series of computers connected to other computers. There are private, and public users in a network who access the internet, and the server provides that essential service.

8.4.4 Utility Software

It is used to manage hardware and application software and also performs small tasks. For example, system utilities and virus scanners, etc.

8.4.5 Windowing System

This graphical user interface component supports the window manager’s implementation, provides pointing devices like keyboards and mice, and supports graphics hardware.

8.4.6 Application programs

This is the top software layer; by using it, we can perform tasks such as writing by using a word processor spreadsheets for accounting; it has two supporting layers: a device driver and an operating system.

8.4.7 Root-user processes

These are programs that users with root authority can run. Through all processes, root authority is given to the administrator.

8.4.8 Assembler

An assembler generally used in an assembly language program is a program that converts the assembly language into machine code. It works on basic commands and code being operated and converted into binary code.

8.4.9 Compiler

The compiler converts the high-level programming language into the machine language. For example, in C or C++ language, we should implement a particular code that is source code in user understandable format print, scan, count, such type of statements will generate in user language. Hence, the compiler converts the source code into the machine language format; machine language code means a target code; that is why we use a compiler for conversion purposes.

8.4.10 Interpreter

The interpreter is also used to convert the source code into the target code, but the interpreter checks one instruction at a time, which means it checks line by line code; it checks the first line, then converts it into the target code, again check the other programming line, and then convert into the target code.

8.4.11 Editor

The editor is the system program used to edit the text in the file. For example, we are all familiar with the Microsoft word processor, an editor whose main tasks are editing, traversing, viewing, and displaying the text. Editor means editing the particular text or file per the user's requirement. In addition, it links extra files extra library files. The type of editors is Line Editor, Screen Editor, Word Processor, and Structure Editor.

8.4.12 Loader

The loader loads the complete program into the memory. When we save a particular program at that time, the program will be stored in the secondary memory. Still, when we compile a program and execute a particular program, the program will be executed into the primary memory, so the loader converts the program's secondary memory to primary memory. It loads a particular program into the secondary to primary memory.

8.4.13 Linker

It is a program that links the user program to another program or library. It links two or more modules into the memory and prepares for execution. It integrates the necessary functions required by the program. Some programming file uses some import functions in different libraries; for example, if we want to use the square-root function in our code, then we have to import 'math. H' library is in our programming, so these libraries are linked with our programming file; this concept is generated through the linker.

8.4.14 Debugger

A debugger is a computer program that finds errors, also called bugs in source code. It provides the facility to halt at any point and check the changes made in the program.

8.4.15 Macro

It is a group of instructions that can be replaced when called by the macro processor. It is used for faster execution, and code can be reusable; also, it is used in assembling language programs.

8.6 System Models

8.5.1 Analysis Model

The analysis model represents the user requirements by depicting the software in three different domains: information domain, functional domain, and behavioural domain. This model is multidimensional. If any deficiency remains in the analysis model, then the errors will be found in the ultimate product to be built. The design modelling phase depends on the analysis model. The Analysis model uses diagrammatic form and text to describe the requirement of data, functions and behaviour of the software to be built.

Mostly it is designed by a software engineer, or system analyst or modeller or project manager. This model describes the problem from the user's end. The essence of the problem is described without any consideration of how a solution will be implemented, and implementation details indicate how the essence will be implemented.

8.5.2. Design Model

Design Model provides variety and different views of the system just like architecture plan for House. Different methods like data-driven, pattern-driven or object-oriented methods are used for constructing the design model. And all these methods use a set of design principles for designing a model. Design must be traceable to the analysis model. User interfaces should consider the user first. Always consider the architecture of the system to be built. Focus on the design of data. Component level design should exhibit functional independence. Both user and internal must be designed. Components should be loosely coupled.

8.5.3. Context Model

The context model is used to specify the boundaries of a system. It represents the system as a whole. When we want to design a context model, we should know the answer and what process make up a system? Social and organizational issues may affect the decision on where to position the system boundaries. This model shows the system and its relationship with other systems.

8.5.4. Behavioural Model

Behavioural Model describe the overall behaviour of the system. To represent system behaviour, two models use one is Data processing model, i.e. DFD (Data Flow Model), and another is state machine model, i.e. state diagram.

Data Flow Diagram:

It is used to model the system data processing, also known as a functional model, as it is a graphical representation of an enterprise function within a defined scope. It shows end to end processing of data. It takes an input – process – output view of the system. It can be easily converted into software as they just represent the flow of data objects. This diagram

enables a software engineer to develop a model of the information domain and Functional domain at the same time. The data processing model is the core modelling activity in structured analysis.

8.5.5 State Machine Model

The state is the mode or condition of being. A state diagram is a dynamic model that shows changes of state that an object goes through during its lifetime in response to an event. It is used to help the developer better understand any complex functionality of specialized areas of the system. It depicts the dynamic behaviour of the system in response to an external and internal event. Likewise, it uses various notation to show the function such as initial state, final state, state, transition, event, action, history site, signal, the action inside the state, self-transition.

8.5.6 Data Model

Analysis modelling starts with data modelling. Software Engineer defines all data objects which are required for the system. It is used to describe the logical structure of the data processed by the system. ER (Entity Relation Attribute Model) is one type of data model that illustrates the entities in the system, their attributes and relationships between entities. Elements of data modelling help to provide appropriate information to understand the problem.

This data modelling concept is called as cardinality. ER diagram consists of information required for each entity or data objects as well as it shows the relation between object also. IT shows the structure of the data in terms of the tables. There are three types of relations that exist between these objects – one to one relation, one to many relations and many-to-many relation.

8.5.7 Object Model

Object model consists of former properties and procedures and methods which tell us how to access these properties. The goal of class modelling is to describe the object. An object is a concept, abstraction or thing which identifies that has meaning for an application. The object model shows individual objects and the relation between them. It is helpful for documenting test cases and discussing examples. It is very useful to understand uncovered rules definition of resources and their relationship. Object diagrams are valuable because they support the investigation of requirements by modelling the examples from the problem domain.

8.6 System design

The process of defining a system's entire requirements, such as the architecture, modules, interface, and design, is called system design. We can say that system design ranges from discussing about the system requirements to product development. System development creates or alters the system so that the processes, practices and methodologies are changed to develop the system. Therefore, a systematic approach is needed to manage the system requirements and design methodology. It can be classified as logical design and physical design. The logical design represents the abstract dataflow, while the physical design represents the system's input and output processes.

8.6.1 Understanding System Design

This approach took before the 2nd world war when the engineers required a system to solve complex issues and communication problems. The required platform standardizes their

work into a framework with accurate and precise methods and information
The various subsets of System Design
The different subsets of this are –

8.6.2 Logical Design

It is the abstract representation of the data flow, inputs, and outputs of the system. It explains the sources, destinations, data stores, and data flows all in a process that satisfies the user needs. The logical design of a system is prepared while keeping the level of detail that virtually tells the information flow and out of the system in mind. The data flow and E-R diagrams are used, respectively.

8.6.3 Physical Design

The process of actual input and output of the system is related to physical design. The main criteria of physical design are to manage how the data is verified, processed, and displayed as a result. It basically revolves around the interface design, process design, and data design of the user.

8.6.4 Architectural Design

It is also called the high level of design that emphasizes the design of system architecture. It explains the nature and root of the system.

8.6.5 Detailed Design

It follows the Architectural Design and emphasizes the development of every subject.

What can you do with System Design?

1. It has proved wonders to many companies and industries. This can reduce system downtime, cut costs and speed up the maintenance work.
2. It helps in the training of new users to easily understand the flow of the system.
3. It helps the user to solve the issues such as troubleshooting and aids the manager to perform better final decisions of the organization system.
4. Working with System Design
5. Working with this is easy, and it speeds up the process of creating applications. There are four main types of documentation that follow with System Design-

1. Program Documentation: It explains the inputs, outputs, and processing logic for all the program courses.

2. System Documentation: It describes the system functions and the way they are implemented.

3. Operations Documentation: It explains the program, system analyst, programmer, and system identification.

4. User Documentation: It includes steps and information to the users who will communicate with the system.

8.7 Advantages of System Design

Some of the major pros of using this are-

1. It reduces the cost of designing.
2. It eliminates inconsistencies.
3. It speeds up the process.
4. It makes the life of the customer easier and simpler.
5. It provides a lot of resources.
6. Required System Design skills
7. Before beginning to learn this, users should have a good knowledge of product development and data processing. A brief understanding of interfaces, modules, and architecture will be an add-on for users who want to learn System Designing.

Why should we use System Design?

While designing systems, there are three primary uses that should be taken into mind, and those are-

1.Reliability

It means the ability of a system to endure faults or problems to prevent failures or complete shutdowns. The beauty and advantage of this are to build fault-tolerant systems using fault intolerant parts.

2. Scalability

Scalability is the system's ability to perform and give a reasonable performance in the situation of heavy load. Performance can be thought of as the system's operating traits when the system's load parameter is changed. These are used to overcome these problems and reduce the efforts of the user.

3. Maintainability

This means writing code that simply is understood and upgraded by someone who is not the original author of the code. Good Code should have clean APIs and interfaces to construct new functionalities every time.

8.8 Summary

we conclude that there are three basic components in a software system, the application software, the device driver, and the operating system; these three work together to perform useful tasks, and it has some translator as they are also components of the software system and they perform completely different types of jobs. The business of business is to make money and profit. The advantage of using this is to improve business quality with increased profits. A functional system's benefit consists of maximum levels of quality control and lower production cost by processing the product and data processing. It is a necessary requirement in any industry and company

8.9 key words

CPU- The CPU controls the computer processes and communicates with the other components of a personal computer.

Mother Board- The motherboard provides the structure for all other components and connects them, while also providing a way to distribute power, deliver information and connect to devices such as a printer or mouse.

RAM - RAM is where data lives temporarily while it's being actively used by programs, such as when a user launches a computer application.

A video graphics array (VGA) port is a video input that is primarily used on PC monitors

Hard drives - Hard drives are data storage devices used to store files, programs or other information on a computer system.

Scanner- A scanner is a device that digitally copies an image or and makes it available as a file for access on a computer

Language translator - Language translator is used to converting the high-level programming language into machine-level language because the machine only understands the machine-level language

Interpreter- The interpreter is also used to convert the source code into the target code, but the interpreter checks one instruction at a time, which means it checks line by line code

Debugger- A debugger is a computer program that finds errors, also called bugs in source code. It provides the facility to halt at any point and check the changes made in the program

8.10 Self Assessment Questions

1. Define CPU? Explain its Components of CPU
2. Briefly Discuss the Feature of System Software
3. Explain the operating System
4. Discuss the System Model and System Design and it Advantages

8.11 Suggested Readings

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LESSON- 9

INTRODUCTION TO MANAGEMENT INFORMATION SYSTEM

Learning Objectives

- ✓ To understand management information system
- ✓ To learn key functions of management information system
- ✓ To study nature of management information system
- ✓ To know the scope of management information system
- ✓ To understand the significance of management information system
- ✓ To analyze the evolution of management information system
- ✓ To know the components of management information system
- ✓ To study the types of management information system
- ✓ To understand the strategic advantages of management information system

Structure

9.1 Introduction

Management Information System (MIS) refers to a computer-based system that provides managers at all levels of an organization with the necessary information to make informed decisions. It involves the collection, processing, storage, and dissemination of data in a structured and organized manner. MIS plays a crucial role in supporting managerial activities, enhancing decision-making processes, and facilitating the overall efficiency and effectiveness of an organization. The primary purpose of an MIS is to transform raw data into meaningful and useful information that can be used for strategic planning, operational control, and

problem-solving. It encompasses various components, such as hardware, software, data, procedures, and people, working together to process and manage information.

9.2 Key functions of a Management Information System

9.2.1. Data collection: Gathering relevant data from various sources, including internal and external databases, sensors, and other systems.

9.2.2. Data processing: Organizing, analyzing, and transforming raw data into meaningful information through calculations, comparisons, and other data manipulation techniques.

9.2.3. Data storage: Storing information in databases or other data repositories for easy and secure access.

9.2.4. Data retrieval: Retrieving specific information when needed by managers or users through query and reporting mechanisms.

9.2.5. Data dissemination: Presenting information in a user-friendly format, such as reports, charts, and dashboards, to enable effective decision-making.

9.2.6. Decision support: Providing managers with tools and models to assist in analyzing data, evaluating alternatives, and making informed decisions.

9.2.7. Planning and control: Supporting strategic planning processes, monitoring organizational performance, and facilitating control mechanisms.

9.2.8. Communication and collaboration: Facilitating information sharing and collaboration among different departments and levels of management within an organization.

MIS can be applied in various functional areas of an organization, including finance, marketing, human resources, operations, and logistics. It helps managers track key performance indicators, identify trends, anticipate problems, and seize opportunities.
Overall, an effective Management Information System empowers managers with timely, accurate, and relevant information, enabling them to make data-driven decisions and gain a competitive advantage in the dynamic business environment.

9.3 Nature of Management Information Systems:

9.3.1. Information Processing: MIS involves the collection, processing, storage, and dissemination of data to generate useful information for decision-making.

9.3.2. Decision Support: It provides managers with the necessary information and tools to support their decision-making processes.

9.3.3. Integration: MIS integrates data from various sources and departments within an organization to provide a holistic view of the organization's operations.

9.3.4. Future Orientation: MIS focuses on providing forward-looking information, enabling managers to anticipate future trends and make proactive decisions.

9.3.5. Control: MIS helps in monitoring and controlling organizational activities by providing real-time information and performance indicators.

9.3.6. Interdisciplinary Approach: It draws upon concepts and techniques from various disciplines such as management, computer science, and data analysis.

9.4 Scope of Management Information Systems:

9.4.1. **Strategic Planning:** MIS supports the strategic planning process by providing relevant information for setting organizational goals, formulating strategies, and evaluating performance.

9.4.2. **Operational Control:** It facilitates day-to-day operational control by monitoring activities, tracking performance, and identifying deviations from plans.

9.4.3. **Decision Support:** MIS provides managers with information and analytical tools to evaluate alternatives, assess risks, and make informed decisions.

9.4.4. **Performance Evaluation:** MIS helps in measuring and evaluating the performance of individuals, departments, and the overall organization against set targets and benchmarks.

9.4.5. **Resource Management:** It assists in managing resources such as finances, inventory, human resources, and production processes more efficiently and effectively.

9.4.6. **Communication and Collaboration:** MIS enables the sharing of information and collaboration among different levels and departments within an organization, promoting better coordination and synergy.

9.5 Significance of Management Information Systems:

9.5.1. Improved Decision-Making: MIS provides accurate, timely, and relevant information, enabling managers to make informed decisions based on data and analysis.

9.5.2. Increased Efficiency: It streamlines operations, automates routine tasks, and reduces manual efforts, leading to improved efficiency and productivity.

9.5.3. Enhanced Competitive Advantage: Effective use of MIS can provide a competitive edge by facilitating quick response to market changes, identifying opportunities, and optimizing resources.

9.5.4. Better Planning and Control: MIS supports effective planning and control mechanisms, allowing managers to set targets, monitor performance, and take corrective actions.

9.5.5. Effective Communication and Collaboration: MIS facilitates information sharing and collaboration among employees, departments, and business partners, promoting effective communication and teamwork.

9.5.6. Improved Customer Service: MIS enables better understanding of customer needs, preferences, and behavior, leading to improved customer service and satisfaction.

9.5.7. Data-Driven Insights: MIS generates valuable insights from data analysis, enabling organizations to identify trends, patterns, and opportunities for innovation and growth.

9.6 Evolution of Management Information Systems

The evolution of Management Information Systems (MIS) can be traced back to the early 20th century, and it has undergone significant advancements over the years. Here is a brief overview of the key stages in the evolution of MIS:

9.6.1. Manual Systems: In the early days, MIS relied on manual processes, where data was collected, processed, and stored manually using paper-based methods. This involved manual calculations, filing systems, and paper-based reports.

9.6.2. Mainframe Systems: With the advent of computers in the 1950s and 1960s, MIS started utilizing mainframe systems. These large-scale computers were capable of processing massive amounts of data and supporting multiple users. Mainframe systems introduced batch processing and improved data storage and retrieval capabilities.

9.6.3. Decision Support Systems (DSS): In the 1970s and 1980s, DSS emerged as a key component of MIS. DSS focused on providing interactive tools and models to assist managers in decision-making. It incorporated concepts such as data analysis, simulations, and "what-if" scenarios.

9.6.4. Personal Computers (PCs) and Local Area Networks (LANs): The widespread adoption of PCs in the 1980s brought computing power and data processing capabilities to individual users. LANs enabled the sharing of information and resources within organizations, facilitating collaboration and information exchange.

9.6.5. Client-Server Architecture: In the 1990s, the client-server architecture gained popularity. This decentralized approach involved distributing computing tasks between a client (user interface) and a server (data storage and processing). It allowed for more scalable and flexible systems.

9.6.6. Internet and Web-based Systems: The emergence of the internet in the late 1990s revolutionized MIS. Web-based systems and applications enabled users to access information and perform tasks remotely through browsers. This opened up new possibilities for communication, collaboration, and data sharing.

9.6.7. Enterprise Resource Planning (ERP) Systems: ERP systems integrated various functional areas of an organization, such as finance, sales, and supply chain, into a single system. This integration enhanced data consistency, eliminated redundancy, and enabled cross-functional analysis.

9.6.8. Cloud Computing and Big Data: The advent of cloud computing provided organizations with flexible and scalable computing resources without the need for extensive infrastructure. Big data technologies allowed for the processing and analysis of large volumes of data, providing valuable insights for decision-making.

9.6.9. Mobile and Real-time Systems: The proliferation of mobile devices and wireless connectivity enabled users to access MIS applications and information on-the-go. Real-time systems allowed for immediate access to up-to-date data, enabling faster decision-making.

9.6.10. Artificial Intelligence (AI) and Analytics: Recent advancements in AI, machine learning, and analytics have transformed MIS capabilities. AI-powered systems can automate tasks, analyze complex data sets, and provide intelligent insights to support decision-making.

9.7 Components of Management Information System

A Management Information System (MIS) consists of several components that work together to process and manage information within an organization. The key components of an MIS include:

9.7.1. **Hardware:** Hardware components include the physical equipment used to collect, process, store, and transmit data. This includes computers, servers, networking devices, storage devices, and peripheral devices such as printers and scanners.

9.7.2. **Software:** Software components refer to the programs and applications used to process and manipulate data within the MIS. This includes operating systems, database management systems, programming languages, and specialized software for data analysis, reporting, and decision support.

9.7.3. **Data:** Data is a fundamental component of an MIS. It refers to raw facts, figures, and observations collected from various sources within and outside the organization. Data can be structured (organized in a predefined format) or unstructured (such as text documents, images, or multimedia files).

9.7.4. **Procedures:** Procedures define the rules, guidelines, and processes for collecting, processing, storing, and disseminating data within the MIS. This includes data entry procedures, data validation processes, backup and recovery procedures, and security protocols.

9.7.5. **People:** People are an essential component of an MIS. This includes users who input, access, and analyze data, as well as IT professionals who develop, manage, and maintain the system. Training and user support are crucial to ensure effective utilization of the MIS by individuals at all levels of the organization.

9.7.6. **Networks:** Networks refer to the communication infrastructure that connects different components of the MIS, enabling data transmission and sharing. This includes Local Area Networks (LANs), Wide Area Networks (WANs), internet connectivity, and other networking technologies.

9.7.7. **Procedures:** Procedures define the rules, guidelines, and processes for collecting, processing, storing, and disseminating data within the MIS. This includes data entry procedures, data validation processes, backup and recovery procedures, and security protocols.

9.7.8. **Policies:** Policies outline the principles and guidelines for the use, access, and security of the MIS. These policies address data privacy, information security, user roles and responsibilities, and compliance with relevant regulations.

9.8 Types of Management Information Syste

There are several types of Management Information Systems (MIS) that cater to different organizational needs and functions. The major types of MIS include the following:

9.8.1. **Transaction Processing System (TPS):** TPS is the foundational level of MIS and handles the processing of routine transactions and day-to-day operational data. It focuses on data collection, storage, and retrieval, and supports basic business processes like sales, inventory, and payroll.

9.8.2. **Decision Support System (DSS):** DSS is designed to support managerial decision-making by providing interactive tools and models for analyzing complex data and evaluating

alternative courses of action. It assists managers in solving unstructured problems and making strategic decisions.

9.8.3. **Executive Information System (EIS):** EIS is specifically developed for top-level executives to provide them with a summarized and highly customizable view of key performance indicators (KPIs) and critical data relevant to strategic decision-making. It offers graphical displays, trend analysis, and drill-down capabilities.

9.8.4. **Management Reporting System (MRS):** MRS focuses on generating regular reports that provide managers with predefined information about various operational aspects, such as sales reports, financial statements, and inventory summaries. It helps managers monitor performance and make informed decisions.

9.8.5. **Marketing Information System (MkIS):**MkIS supports marketing activities by gathering, analyzing, and reporting information related to market trends, customer behavior, competitive analysis, and product performance. It aids in market research, segmentation, targeting, and planning marketing strategies.

9.8.6. **Financial Information System (FIS):** FIS deals with financial data and processes, including financial planning, budgeting, accounting, and reporting. It provides managers with financial statements, cash flow analysis, profitability reports, and other financial information necessary for decision-making.

9.8.7. **Human Resource Information System (HRIS):** HRIS focuses on managing employee-related information, including recruitment, training, performance evaluation, payroll, and benefits administration. It assists HR managers in workforce planning, talent management, and employee engagement.

9.8.8. **Supply Chain Management System (SCMS):** SCMS integrates and manages the flow of goods, services, and information across the supply chain, including suppliers, manufacturers, distributors, and customers. It optimizes inventory levels, tracks shipments, manages logistics, and enhances coordination among supply chain partners.

9.8.9. **Enterprise Resource Planning System (ERP):** ERP integrates various functions and departments of an organization, such as finance, sales, production, and procurement, into a centralized system. It provides a comprehensive view of business processes and supports cross-functional information sharing and collaboration.

9.8.10. **Knowledge Management System (KMS):** KMS focuses on capturing, organizing, and sharing knowledge within an organization. It includes knowledge repositories, collaboration platforms, and search tools to facilitate knowledge creation, storage, and retrieval.

These types of MIS can be implemented individually or in combination, depending on the specific needs and objectives of an organization. The choice of MIS depends on factors such as organizational size, industry, functional requirements, and strategic goals.

9.9 Strategic Advantages of Management Information Systems (MIS)

1.**Improved Decision-Making:** MIS provides timely, accurate, and relevant information to managers, enabling them to make informed decisions based on data and analysis. This leads to better strategic planning, resource allocation, and problem-solving.

2.**Competitive Advantage:** Effective use of MIS can provide a competitive edge by facilitating quick response to market changes, identifying opportunities, and optimizing resources. It enables organizations to stay ahead of competitors and adapt to changing business environments.

3.**Enhanced Efficiency and Productivity:** MIS streamlines business processes, automates routine tasks, and reduces manual efforts. It improves operational efficiency, eliminates redundant activities, and enhances productivity throughout the organization.

4.**Real-time Information:** MIS provides real-time access to data and key performance indicators, enabling managers to monitor operations and make timely adjustments. It allows for proactive decision-making and better control over organizational activities.

5.**Data-driven Insights:** MIS facilitates data analysis and reporting, generating valuable insights for decision-making. It helps in identifying trends, patterns, and correlations in data, which can lead to innovation, process improvement, and optimization of business strategies.

6.**Effective Communication and Collaboration:** MIS enables information sharing, collaboration, and coordination among different departments and levels of management within an organization. It improves communication flows, reduces information silos, and promotes teamwork.

9.10 Limitations of Management Information Systems (MIS)

1.**Cost and Complexity:** Implementing and maintaining an MIS can be costly, requiring investments in hardware, software, infrastructure, and skilled personnel. Complexity in system integration, data management, and user training can also pose challenges.

2.**Data Quality and Integrity:** MIS heavily relies on the accuracy, completeness, and reliability of data. Poor data quality or integrity issues can lead to incorrect information and faulty decision-making. Data cleansing and validation processes are essential to ensure the accuracy and reliability of the system.

3.**Resistance to Change:** The implementation of MIS may face resistance from employees who are accustomed to existing manual or legacy systems. Resistance to change can hinder adoption and utilization of the system, impacting its effectiveness.

4.**Security and Privacy Risks:** MIS involves the storage and processing of sensitive and confidential information. Data breaches, unauthorized access, or system vulnerabilities can pose security and privacy risks. Appropriate security measures, such as encryption and access controls, must be implemented to mitigate these risks.

5.**Overreliance on Technology:** Overdependence on technology and automated systems can lead to a loss of critical thinking and creativity. Managers may become overly reliant on system-generated reports and fail to analyze data critically or consider qualitative factors.

6.**Need for Skilled Personnel:** Effective utilization of MIS requires skilled personnel who can manage, analyze, and interpret the data. Organizations need to invest in training and development to ensure that employees have the necessary skills to maximize the benefits of the system.

9.11 Summary

MIS can be applied in various functional areas of an organization, including finance, marketing, human resources, operations, and logistics. It helps managers track key

performance indicators, identify trends, anticipate problems, and seize opportunities.Overall, an effective Management Information System empowers managers with timely, accurate, and relevant information, enabling them to make data-driven decisions and gain a competitive advantage in the dynamic business environment. The seven components work together to facilitate the collection, processing, storage, retrieval, and dissemination of information within an organization. Effective integration and coordination of these components are crucial to ensure the smooth functioning of the MIS and its ability to support decision-making and operational activities.It is important for organizations to understand both the advantages and limitations of MIS in order to maximize its benefits and mitigate potential challenges. Proper planning, ongoing monitoring, and continuous improvement efforts are essential to overcome these limitations and leverage the strategic advantages of an MIS.

9.12 Key Words

Transaction Processing System (TPS): TPS is the foundational level of MIS and handles the processing of routine transactions and day-to-day operational data.

Decision Support System (DSS): DSS is designed to support managerial decision-making by providing interactive tools and models for analyzing complex data and evaluating alternative courses of action.

Executive Information System (EIS): EIS is specifically developed for top-level executives to provide them with a summarized and highly customizable view of key performance indicators (KPIs) and critical data relevant to strategic decision-making.

Management Reporting System (MRS): MRS focuses on generating regular reports that provide managers with predefined information about various operational aspects, such as sales reports, financial statements, and inventory summaries.

Marketing Information System (MkIS): MkIS supports marketing activities by gathering, analyzing, and reporting information related to market trends, customer behavior, competitive analysis, and product performance.

Financial Information System (FIS): FIS deals with financial data and processes, including financial planning, budgeting, accounting, and reporting.

Human Resource Information System (HRIS): HRIS focuses on managing employee-related information, including recruitment, training, performance evaluation, payroll, and benefits administration.

Supply Chain Management System (SCMS): SCMS integrates and manages the flow of goods, services, and information across the supply chain, including suppliers, manufacturers, distributors, and customers.

Enterprise Resource Planning System (ERP): ERP integrates various functions and departments of an organization, such as finance, sales, production, and procurement, into a centralized system.

9.13 Self-Assessment Questions

1. Write a note on MIS and its key functions
2. Explain scope, nature, and significance of management information system
3. What is MIS? Explain Evolution of Management Information Systems
4. What are the components of Components of Management Information System?

5. Explain types of MIS in detail
6. Write a note on Strategic Advantages of Management Information Systems

9.14 Suggested Readings

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LESSON- 10

MANAGEMENT INFORMATION SYSTEM IN MANAGERIAL FUNCTIONS

Learning Objectives

- ✓ To understand MIS application framework
- ✓ To study the role of Management Information System in Human Resource Management
- ✓ To know the advantages and disadvantages of MIS in Human Resource Management
- ✓ To study the role of Management Information System in Financial Management
- ✓ To know the advantages and disadvantages of MIS in Financial Management
- ✓ To study the role of Management Information System in Marketing Management
- ✓ To know the advantages and disadvantages of MIS in Marketing Management

Structure

10.1 Management Information System (MIS) Application Framework

The Management Information System (MIS) application framework provides a structured approach to developing and implementing MIS applications within an organization. It serves as a guide for designing, building, and deploying MIS solutions that align with the organization's needs and objectives. While specific frameworks may vary, a typical MIS application framework consists of the following components:

10.1.1. Requirement Analysis: This phase involves understanding the organization's information needs, business processes, and objectives. It includes identifying the key

stakeholders, conducting interviews, and gathering requirements to define the scope and objectives of the MIS application.

10.1.2. System Design: In this phase, the overall system architecture and design are developed. It includes defining the database structure, user interface, data flow, and system components. The design phase also incorporates considerations such as security, scalability, and performance.

10.1.3. Development: The development phase involves building the MIS application based on the design specifications. It includes programming, database development, creating user interfaces, and integrating various system components. This phase may also involve customization or integration with existing software or systems.

10.1.4. Testing and Quality Assurance: In this phase, the developed MIS application undergoes rigorous testing to ensure its functionality, performance, and reliability. Different types of testing, such as unit testing, integration testing, and user acceptance testing, are performed to identify and fix any issues or bugs.

10.1.5. Deployment and Implementation: Once the MIS application has been thoroughly tested and approved, it is deployed and implemented in the production environment. This involves installing the necessary hardware and software, configuring the system, and migrating data from legacy systems if required. User training and change management processes are also conducted to ensure a smooth transition to the new system.

10.1.6. Maintenance and Support: After the MIS application is deployed, ongoing maintenance and support activities are essential to ensure its smooth operation. This includes monitoring system performance, applying updates and patches, addressing user queries and issues, and continuously improving the system based on user feedback and changing requirements.

10.1.7. Evaluation and Enhancement: Periodic evaluation of the MIS application is conducted to assess its effectiveness, user satisfaction, and alignment with organizational goals. Based on the evaluation, enhancements and upgrades may be identified and implemented to improve the system's functionality and address evolving business needs.

Throughout the framework, considerations such as data security, privacy, regulatory compliance, and user experience are essential. Additionally, project management

methodologies and practices can be integrated into the framework to ensure effective planning, resource allocation, and project control.

10.2 Management Information System (MIS) in Human Resource Management

A Management Information System (MIS) in Human Resource Management (HRM) is a software or system designed to streamline and automate HR processes and provide accurate and timely information for effective HR decision-making. Here are some key aspects of how an MIS can be utilized in HRM:

10.2.1. Employee Data Management: An MIS in HRM stores and manages comprehensive employee data, including personal details, employment history, performance evaluations, training records, and benefits information. It provides a centralized database that allows HR professionals to easily access and update employee information, ensuring data accuracy and efficiency in HR processes.

10.2.2. Recruitment and Selection: An MIS supports the recruitment and selection process by automating job posting, resume screening, applicant tracking, and interview scheduling. It helps HR professionals manage candidate information, track recruitment metrics, and evaluate the effectiveness of recruitment strategies. This streamlines the hiring process and improves the quality of candidate selection.

10.2.3. Performance Management: An MIS facilitates performance management by automating performance appraisal processes, tracking employee goals and objectives, and providing performance-related data and reports. It allows HR professionals and managers to monitor employee performance, provide feedback, and identify areas for improvement. This promotes fair and consistent performance evaluations and helps in talent development and succession planning.

10.2.4. Training and Development: An MIS in HRM supports training and development initiatives by managing training programs, tracking employee training needs, and monitoring training progress. It provides a platform for scheduling and delivering training modules, tracking attendance, and evaluating the effectiveness of training programs. This ensures that employees have access to necessary training and development opportunities for skill enhancement.

10.2.5. Time and Attendance Management: An MIS helps in tracking employee attendance, leave balances, and time-off requests. It automates time tracking systems, facilitates the management of employee schedules, and calculates leave entitlements. This simplifies payroll processing, reduces administrative tasks, and ensures accurate and timely compensation for employees.

10.2.6. Benefits Administration: An MIS assists in managing employee benefits programs, such as health insurance, retirement plans, and other employee benefits. It automates benefits enrolment, tracks employee participation, and generates reports on benefits utilization. This streamlines benefits administration processes and improves employee satisfaction.

10.2.7. HR Analytics and Reporting: An MIS provides HR professionals with access to real-time HR analytics and reports. It enables data analysis on various HR metrics, such as employee turnover, training costs, performance ratings, and diversity metrics. These insights help HR professionals make data-driven decisions, identify trends, and develop strategies to optimize HR processes and align them with organizational goals.

10.2.8. Compliance and Record-Keeping: An MIS in HRM helps ensure compliance with legal and regulatory requirements by maintaining accurate records and supporting HR audits. It assists in generating reports and documents required for legal compliance, such as EEOC reports, OSHA records, and labour law compliance reports. This minimizes the risk of non-compliance and supports HR professionals in maintaining a legally compliant HR environment.

10.3 Advantages of Management Information System (MIS) in Human Resource Management (HRM):

10.3.1. Improved Efficiency: An MIS automates and streamlines HR processes, reducing manual paperwork and administrative tasks. It improves the efficiency of HR operations, such as employee data management, recruitment, performance management, and benefits administration. This allows HR professionals to focus on strategic activities and employee engagement.

10.3.2. Accurate and Timely Information: An MIS provides accurate and up-to-date information about employees, such as personal details, performance evaluations, training records, and benefits information. This ensures data integrity and enables HR professionals to make informed decisions based on reliable information.

10.3.3. Enhanced Decision-Making: An MIS in HRM provides HR professionals with access to real-time HR analytics, reports, and key performance indicators (KPIs). It enables data-driven decision-making in areas like recruitment, performance management, training, and succession planning. This improves the effectiveness of HR strategies and aligns them with organizational goals.

10.3.4. Centralized Data Management: An MIS serves as a centralized database for employee information, making it easily accessible and reducing the need for manual record-keeping. It ensures data consistency, eliminates duplication of effort, and enables efficient retrieval and updating of employee data.

10.3.5. Improved Compliance: An MIS helps HR professionals ensure compliance with legal and regulatory requirements. It assists in generating reports and documents needed for legal compliance, such as tax forms, benefits documentation, and equal employment opportunity reports. This reduces the risk of non-compliance and supports a legally compliant HR environment.

10.4 Disadvantages of Management Information System (MIS) in Human Resource Management (HRM):

10.4.1. Implementation and Maintenance Costs: Implementing an MIS in HRM involves upfront costs, including software, hardware, and system development. Ongoing maintenance and updates also require investments. Small-scale organizations may find it challenging to afford and sustain an MIS.

10.4.2. Data Security Risks: An MIS in HRM deals with sensitive employee information, such as personal details, performance evaluations, and compensation data. Ensuring data security and privacy protection is crucial to prevent unauthorized access, data breaches, or loss of confidential information.

10.4.3. Training and User Adoption: Implementing an MIS may require training for HR professionals and employees to effectively use the system. Resistance to change and the need for training can initially slow down the adoption of the MIS. Organizations should invest in proper training and change management strategies to overcome this challenge.

10.4.4. Reliance on Technology: An MIS heavily depends on technology infrastructure and systems. Technical failures, system downtime, or disruptions can affect HR operations and

lead to delays or inefficiencies. Organizations need backup systems, redundancy measures, and disaster recovery plans to minimize such risks.

10.4.5. Potential for Data Inconsistencies: An MIS in HRM requires accurate and consistent data to produce reliable reports and analytics. Data entry errors or inconsistencies can lead to inaccurate HR information and impact decision-making. Proper data validation and quality control measures need to be in place to ensure data accuracy and reliability.

10.5 Management Information System (MIS) in Financial Management

A Management Information System (MIS) in Financial Management is a system that helps organizations manage and process financial data and information to support financial decision-making and improve overall financial performance. Here are some key aspects of how an MIS can be utilized in financial management:

10.5.1. Financial Planning and Budgeting: An MIS in financial management provides tools and functionalities to facilitate financial planning and budgeting processes. It helps in creating and managing financial budgets, analyzing variances between actual and planned financial performance, and generating financial forecasts. This enables organizations to set financial goals, allocate resources effectively, and monitor financial performance against targets.

10.5.2. Financial Reporting and Analysis: An MIS in financial management enables the generation of financial reports and analysis. It consolidates financial data from various sources, such as general ledger systems, accounts payable, and accounts receivable, to produce comprehensive financial statements, including balance sheets, income statements, and cash flow statements. This provides organizations with a clear and accurate view of their financial position and performance.

10.5.3. Cash Flow Management: An MIS supports cash flow management by providing real-time visibility into cash inflows and outflows. It helps in tracking and analyzing cash flow patterns, managing working capital, and optimizing cash management strategies. This enables organizations to maintain adequate cash reserves, effectively manage liquidity, and mitigate cash flow risks.

10.5.4. Financial Risk Management: An MIS assists in identifying, assessing, and managing financial risks. It provides tools for analyzing and monitoring financial risk factors, such as credit risk, market risk, and liquidity risk. It helps organizations develop risk mitigation strategies and implement internal controls to safeguard financial assets and ensure regulatory compliance.

10.5.5. Financial Decision-Making: An MIS in financial management supports data-driven financial decision-making. It provides financial analysis tools, key performance indicators (KPIs), and reports that aid in evaluating investment opportunities, assessing profitability, and analyzing financial ratios. This enables organizations to make informed decisions about capital investment, financing options, and cost optimization.

10.5.6. Regulatory Compliance: An MIS helps organizations comply with financial regulations and reporting requirements. It ensures accurate and timely reporting of financial information, such as tax filings, financial statements, and regulatory disclosures. This minimizes the risk of non-compliance, penalties, and reputational damage.

10.5.7. Integration with Financial Systems: An MIS can integrate with other financial systems, such as Enterprise Resource Planning (ERP) systems, accounting software, and financial databases. This integration ensures data consistency, eliminates data duplication, and enables seamless information flow across various financial processes and systems.

10.5.8. Audit and Internal Controls: An MIS supports audit and internal control processes by providing tools for monitoring financial transactions, detecting anomalies or irregularities, and generating audit trails. It facilitates compliance with internal control frameworks and assists in conducting internal and external audits.

10.6 Advantages of Management Information System (MIS) in Financial Management

10.6.1. Improved Decision-Making: An MIS provides accurate and timely financial information, enabling managers to make informed decisions. It consolidates financial data, generates reports, and offers analysis tools that help in evaluating financial performance, identifying trends, and forecasting future outcomes. This supports strategic financial decision-making and enhances overall financial management.

10.6.2. Enhanced Financial Planning and Budgeting: An MIS aids in financial planning and budgeting processes by providing a centralized platform for budget creation, monitoring, and analysis. It enables organizations to set realistic financial goals, allocate resources effectively, and track budget performance. This promotes efficient resource utilization and helps in achieving financial targets.

10.6.3. Efficient Financial Reporting and Analysis: An MIS automates financial reporting processes, allowing for efficient and accurate generation of financial statements, such as balance sheets, income statements, and cash flow statements. It also provides analysis tools that help in evaluating financial ratios, profitability, and performance indicators. This facilitates effective financial analysis and supports performance monitoring and evaluation.

10.6.4. Streamlined Financial Operations: An MIS automates routine financial tasks, such as accounts payable and receivable management, invoice processing, and financial transaction recording. It reduces manual efforts, minimizes errors, and improves the efficiency of financial operations. This frees up resources to focus on more strategic financial activities.

10.6.5. Improved Compliance and Risk Management: An MIS facilitates compliance with financial regulations and reporting requirements. It ensures accurate and timely financial reporting, tracks regulatory changes, and helps in monitoring compliance with internal control frameworks. Additionally, it supports risk management by providing tools for analyzing and managing financial risks, such as credit risk and market risk.

10.7 Disadvantages of Management Information System (MIS) in Financial Management

10.7.1. Implementation and Maintenance Costs: Implementing an MIS in financial management can involve significant upfront costs, including software licenses, hardware, and system development. Ongoing maintenance, upgrades, and training requirements also add to the costs. Organizations need to carefully evaluate the return on investment (ROI) before implementing an MIS.

10.7.2. Data Security and Privacy Risks: An MIS deals with sensitive financial data, such as financial statements, budget details, and customer financial information. Ensuring data security, protecting against unauthorized access, and complying with privacy regulations are

critical. Organizations need robust security measures to safeguard financial data and mitigate the risk of data breaches.

10.7.3. Complexity and Integration Challenges: Implementing an MIS requires integration with various financial systems, such as accounting software, ERP systems, and databases. Achieving seamless integration and data consistency can be complex, especially when dealing with legacy systems or multiple data sources. It requires careful planning and coordination to ensure smooth implementation and data synchronization.

10.7.4. Dependency on Technology: An MIS heavily relies on technology infrastructure and systems. Any technical failures, system downtime, or disruptions can impact financial operations and decision-making. Organizations need to have backup systems, redundancy measures, and disaster recovery plans in place to minimize the risks associated with system failures.

10.7.5. User Training and Adaptation: Implementing an MIS requires training for employees to effectively use the system. Resistance to change and the learning curve associated with adopting new technologies can hinder user adoption and utilization of the system. Adequate training, change management strategies, and user support are necessary to overcome these challenges.

10.8 Management Information System in Marketing Management

A management information system (MIS) in marketing management refers to the use of information technology and systems to collect, analyze, and distribute data and information that supports marketing decision-making and activities. It is designed to assist marketing managers in planning, implementing, and controlling marketing strategies and tactics.

Here are some key aspects of a management information system in marketing management:

10.8.1. Data Collection: An MIS collects and stores data from various sources, such as market research, customer databases, sales figures, social media, and website analytics. This data can include information about customer preferences, demographics, purchasing behavior, market trends, competitor activities, and more.

10.8.2. Data Analysis: The collected data is processed and analyzed to extract meaningful insights. Statistical techniques, data mining, and predictive analytics are often used to identify

patterns, trends, and relationships within the data. This analysis helps marketing managers make informed decisions and develop effective marketing strategies.

10.8.3. Marketing Planning and Strategy: An MIS provides valuable information for marketing planning and strategy development. It assists in identifying target markets, understanding customer needs, determining product positioning, setting marketing objectives, and formulating marketing plans. The insights gained from the MIS enable managers to allocate resources effectively and make informed decisions about product development, pricing, promotion, and distribution.

10.8.4. Performance Measurement: A marketing MIS helps in measuring and evaluating the effectiveness of marketing activities. Key performance indicators (KPIs) and metrics are tracked and monitored to assess the performance of marketing campaigns, sales, customer satisfaction, and other relevant marketing variables. This information allows managers to identify areas of improvement, measure return on investment (ROI), and make data-driven decisions to optimize marketing efforts.

10.8.5. Communication and Collaboration: An MIS facilitates communication and collaboration among marketing team members and other stakeholders. It enables the sharing of information, reports, and insights across the organization, fostering better coordination and alignment of marketing activities. Collaboration tools within the MIS can enhance teamwork and streamline decision-making processes.

10.8.6. Forecasting and Market Analysis: By leveraging historical data and market trends, an MIS can assist marketing managers in forecasting future demand, predicting sales volumes, and analyzing market opportunities and threats. This helps in strategic decision-making, resource allocation, and identifying potential risks and opportunities in the market.

10.9 Advantages of Management Information System in Marketing Management

10.9.1. Enhanced Decision-Making: An MIS provides accurate and timely information to marketing managers, enabling them to make well-informed decisions. It helps managers analyze market trends, customer preferences, and competitor activities, leading to more effective marketing strategies and tactics.

10.9.2. Improved Efficiency: By automating data collection, analysis, and reporting processes, an MIS streamlines marketing operations and reduces manual work. It saves time and effort by eliminating repetitive tasks, allowing marketing teams to focus on strategic activities and value-added tasks.

10.9.3. Data Integration: An MIS integrates data from various sources and departments within the organization, providing a holistic view of marketing-related information. It eliminates data silos and facilitates cross-functional collaboration, leading to improved coordination and synergy among different marketing functions.

10.9.4. Real-time Monitoring: With an MIS, marketing managers can monitor key performance indicators (KPIs) and metrics in real time. This enables them to track marketing campaigns, sales performance, and customer feedback, allowing for quick adjustments and timely interventions if needed.

10.9.5. Targeted Marketing: An MIS helps identify and segment target markets based on customer data and preferences. It enables personalized marketing campaigns, tailored messaging, and customized offerings, leading to higher customer satisfaction and improved marketing effectiveness.

10.10 Disadvantages of Management Information System in Marketing Management

10.10.1.Costly Implementation: Implementing an MIS can involve significant upfront costs,including hardware, software, infrastructure, and training expenses. Smaller organizations with limited budgets may find it challenging to invest in a robust MIS system.

10.10.2.Data Quality and Accuracy: An MIS relies heavily on the quality and accuracy of the data it collects and processes. If the data is incomplete, inconsistent, or unreliable, it can lead to incorrect analyses and flawed decision-making. Maintaining data integrity and ensuring data quality can be a complex and ongoing challenge.

10.10.3.Technical Challenges: Managing an MIS requires technical expertise to set up, maintain, and troubleshoot system issues. Organizations may need to invest in IT staff or outsource technical support, which can add to the overall cost of implementing and managing an MIS.

10.10.4.Resistance to Change: Introducing an MIS can disrupt existing workflows and processes, which may face resistance from employees. Some employees may find it difficult to adapt to new technologies or fear job displacement. Proper change management and training programs are necessary to mitigate resistance and ensure smooth adoption.

10.10.5.Security and Privacy Risks: An MIS stores sensitive customer and market data, making it a potential target for cyberattacks and data breaches. Maintaining robust security measures and complying with data protection regulations is crucial to protect sensitive information and maintain customer trust.

10.11 Summary

By following an MIS application framework, organizations can systematically develop, implement, and maintain MIS solutions that provide accurate, timely, and relevant information to support decision-making, improve operational efficiency, and gain a competitive advantage.Overall, an MIS in HRM improves HR efficiency, accuracy, and decision-making by providing a centralized platform for managing employee data, automating HR processes, and generating relevant reports and analytics. It enhances employee management, promotes HR best practices, and supports strategic HR planning within organizations.Organizations should carefully consider the advantages and disadvantages of implementing an MIS in HRM. Thorough planning, stakeholder involvement, and ongoing monitoring and improvement efforts are necessary to maximize the benefits and mitigate the potential drawbacks of an MIS in HRM.MIS in financial management enhances financial decision-making, improves financial planning and reporting processes, supports risk management efforts, and enables organizations to have better control over their financial performance. It provides accurate and timely financial information, facilitates analysis, and helps organizations make informed decisions to achieve their financial objectives. Management information system in marketing management provides a comprehensive and integrated approach to collecting, analyzing, and utilizing data and information for effective marketing decision-making. It helps marketing managers gain valuable insights, improve marketing performance, and stay competitive in today's dynamic business environment.

10.12 Key Words

Requirement Analysis: This phase involves understanding the organization's information needs, business processes, and objectives. It includes identifying the key stakeholders,

conducting interviews, and gathering requirements to define the scope and objectives of the MIS application.

Testing and Quality Assurance: In this phase, the developed MIS application undergoes rigorous testing to ensure its functionality, performance, and reliability. Different types of testing, such as unit testing, integration testing, and user acceptance testing, are performed to identify and fix any issues or bugs.

HR Analytics and Reporting: An MIS provides HR professionals with access to real-time HR analytics and reports. It enables data analysis on various HR metrics, such as employee turnover, training costs, performance ratings, and diversity metrics.

Data Security Risks: An MIS in HRM deals with sensitive employee information, such as personal details, performance evaluations, and compensation data. Ensuring data security and privacy protection is crucial to prevent unauthorized access, data breaches, or loss of confidential information.

Financial Reporting and Analysis: An MIS in financial management enables the generation of financial reports and analysis. It consolidates financial data from various sources, such as general ledger systems, accounts payable, and accounts receivable, to produce comprehensive financial statements, including balance sheets, income statements, and cash flow statements.

10.13 Self-Assessment Questions

1. Explain management information system application framework
2. What are the key aspects management information system in HRM?
3. Explain the advantages and disadvantages of management information system in HRM
4. What are the key aspects management information system in Financial Management?
5. Explain the advantages and disadvantages of management information system in Financial Management
6. What are the key aspects management information system in Marketing Management?
7. Explain the advantages and disadvantages of management information system in Marketing Management

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LESSON- 11

MANAGEMENT INFORMATION SYSTEM IN MANUFACTURING SECTOR

Learning Objectives

- ✓ To study manufacturing sector in India
- ✓ To understand Role of Technology in Manufacturing Sector
- ✓ To know functions of Management Information System in Production Management
- ✓ To analyze the advantages and disadvantages of MIS in Production Management
- ✓ To know functions of Management Information System in Material Management
- ✓ To analyze the advantages and disadvantages of MIS in Material Management

Structure

11.1 Manufacturing Sector in India

The manufacturing sector in India plays a crucial role in the country's economic development. It contributes significantly to GDP growth, employment generation, and export earnings. India has emerged as one of the world's largest manufacturing hubs and is known for its diverse range of industries.

Here are some key points about the manufacturing sector in India:

11.1.1. Growth and Contribution: The manufacturing sector in India has been growing steadily over the years. It contributes around 16-17% to India's GDP and provides employment to a significant portion of the workforce. The government has been emphasizing the "Make in India" initiative to boost manufacturing and attract investments.

11.1.2. Diversified Industries: India's manufacturing sector covers a wide range of industries, including automobiles, textiles, pharmaceuticals, chemicals, machinery, electronics, steel, and food processing, among others. The country has developed expertise in several sectors, with many Indian companies becoming global players.

11.1.3. Foreign Direct Investment (FDI): The Indian government has been actively promoting foreign direct investment in the manufacturing sector. FDI inflows have increased in recent years, with multinational companies setting up manufacturing units in India. The government has implemented several reforms to improve ease of doing business and provide incentives for investment.

11.1.4. Make in India: Launched in 2014, the Make in India campaign aims to transform India into a global manufacturing hub. It focuses on attracting investments, enhancing skill development, fostering innovation, and improving infrastructure. The campaign has led to increased manufacturing activity and the creation of jobs.

11.1.5. Government Initiatives and Policies: The Indian government has implemented various initiatives and policies to support the manufacturing sector. These include the National Manufacturing Policy, Goods and Services Tax (GST), Special Economic Zones (SEZs), and initiatives to promote renewable energy and sustainable manufacturing practices.

11.1.6. Challenges: The manufacturing sector in India also faces certain challenges. These include complex regulatory procedures, inadequate infrastructure, skill gaps, high logistics costs, and limited access to credit for small and medium-sized enterprises. The government has been working to address these issues through reforms and policy measures.

11.1.7. Export Potential: The manufacturing sector plays a crucial role in India's export earnings. Indian manufacturers export a wide range of goods, including automobiles, textiles, pharmaceuticals, engineering goods, and chemicals. The government has implemented various export promotion schemes to enhance competitiveness and market access for Indian manufacturers.

11.2 Manufacturing Organisations in India

India is home to numerous manufacturing companies across various industries. Here are some notable manufacturing sector companies in India:

11.2.1. Tata Group: The Tata Group is one of India's largest conglomerates with interests in multiple sectors, including automotive, steel, chemicals, information technology, and consumer goods. Tata Motors, Tata Steel, Tata Chemicals, and Tata Power are some of the prominent companies within the group.

11.2.2. Reliance Industries Limited: Reliance Industries is a diversified conglomerate with operations in petrochemicals, refining, oil and gas exploration, telecommunications, retail, and textiles. It is one of the largest private sector companies in India.

11.2.3. Mahindra & Mahindra: Mahindra & Mahindra is a leading manufacturer of automobiles, tractors, utility vehicles, and agricultural machinery. It is known for its popular brands such as Scorpio, Bolero, XUV500, and Thar.

11.2.4. Maruti Suzuki: Maruti Suzuki is India's largest car manufacturer and a subsidiary of Suzuki Motor Corporation, Japan. It produces a wide range of cars, including popular models like Swift, Dzire, Baleno, and Alto.

11.2.5. Bajaj Auto: Bajaj Auto is a prominent manufacturer of motorcycles, scooters, and three-wheelers in India. It offers popular models such as Pulsar, Avenger, Dominar, and Chetak.

11.2.6. Hero MotoCorp: Hero MotoCorp is the world's largest manufacturer of motorcycles and scooters. It produces a range of two-wheelers, including popular models like Splendor, Passion, and Glamour.

11.2.7. Larsen & Toubro (L&T): Larsen & Toubro is a leading engineering and construction conglomerate with operations in various sectors, including infrastructure, power, heavy engineering, and defense. It is involved in manufacturing heavy equipment, electrical and automation systems, and more.

11.2.8. Hindustan Unilever Limited (HUL): HUL is one of India's largest fast-moving consumer goods (FMCG) companies. It manufactures and markets a wide range of products across categories such as personal care, home care, food, and beverages.

11.2.9. Godrej Group: The Godrej Group is a conglomerate with interests in various sectors, including consumer goods, real estate, appliances, furniture, and industrial engineering. It manufactures products ranging from soaps and hair care to refrigerators and furniture.

11.2.10. Adani Group: The Adani Group is a diversified conglomerate involved in sectors like ports, logistics, energy, mining, and manufacturing. It operates businesses such as Adani Ports and Special Economic Zone (SEZ), Adani Power, and Adani Wilmar.

11.2.11. ITC Limited: ITC Limited is a leading diversified conglomerate with businesses in sectors like cigarettes and tobacco, hotels, paperboards, packaging, and agri-business. It manufactures popular brands like Aashirvaad, Sunfeast, Bingo, and Classmate.

These are just a few examples of the many manufacturing sector companies in India. The country has a vibrant and diverse manufacturing landscape with companies operating across various industries.

11.3 Role of Technology in Manufacturing Sector

Technology plays a crucial role in the manufacturing sector, driving innovation, efficiency, and competitiveness. It has transformed traditional manufacturing processes and enabled the development of advanced techniques and products. Here are some key roles of technology in the manufacturing sector:

11.3.1. Automation and Robotics: Technology has enabled the automation of various manufacturing processes, minimizing human intervention and increasing efficiency. Robotics and robotic automation systems are used for tasks such as assembly, material handling, quality control, and packaging. This improves productivity, reduces costs, and enhances product quality.

11.3.2. Internet of Things (IoT) and Connectivity: IoT technology allows the interconnectivity of machines, equipment, and systems in the manufacturing environment. This enables real-time monitoring, data collection, and analysis, leading to predictive maintenance, improved supply chain management, and better decision-making. IoT also facilitates the integration of various processes for seamless operations.

11.3.3. Additive Manufacturing (3D Printing): Additive manufacturing, commonly known as 3D printing, has revolutionized the manufacturing industry. It allows the creation of complex prototypes, customized products, and spare parts with greater flexibility and speed. 3D printing reduces material waste, enables rapid prototyping, and provides cost-effective manufacturing solutions.

11.3.4. Advanced Materials and Nanotechnology: Technology has enabled the development and use of advanced materials in manufacturing. Nanotechnology, for instance, has led to the creation of stronger, lighter, and more durable materials with unique properties. These materials find applications in sectors like aerospace, automotive, electronics, and healthcare, enhancing product performance and efficiency.

11.3.5. Artificial Intelligence (AI) and Machine Learning (ML): AI and ML technologies are increasingly employed in manufacturing for process optimization, quality control, predictive maintenance, and supply chain management. These technologies analyze large datasets, identify patterns, and make intelligent decisions, improving operational efficiency, reducing downtime, and optimizing resource allocation.

11.3.6. Cloud Computing and Big Data Analytics: Cloud computing enables manufacturers to store and access large amounts of data securely. Big data analytics tools process this data,

providing valuable insights for process optimization, quality improvement, demand forecasting, and customer behavior analysis. Manufacturers can make data-driven decisions to enhance productivity and streamline operations.

11.3.7. Virtual Reality (VR) and Augmented Reality (AR): VR and AR technologies are utilized in manufacturing for product design, prototyping, and employee training. They enable virtual simulations, 3D modeling, and interactive visualization, allowing manufacturers to test and refine designs before physical production. AR also assists workers by providing real-time information and instructions, reducing errors and enhancing efficiency.

11.3.8. Supply Chain Management and Logistics: Technology plays a critical role in optimizing supply chain management and logistics operations. It facilitates real-time tracking and tracing of goods, inventory management, demand forecasting, and efficient order fulfillment. Technologies like GPS, RFID, and blockchain enhance transparency, traceability, and efficiency throughout the supply chain.

11.3.9. Sustainable Manufacturing Practices: Technology supports sustainable manufacturing by enabling energy-efficient processes, waste reduction, and environmental monitoring. Smart sensors, automation, and data analytics help optimize resource consumption, minimize waste generation, and ensure compliance with environmental regulations.

11.3.10. Collaborative Platforms and Digital Twins: Collaborative platforms and digital twins allow manufacturers to connect with suppliers, customers, and partners in a digital ecosystem. These platforms facilitate seamless collaboration, information sharing, and real-time visibility across the value chain. Digital twins enable virtual replicas of physical products or processes, aiding in design optimization, troubleshooting, and predictive maintenance.

11.4 Management Information System in Production Management

In the context of production management, a Management Information System (MIS) plays a crucial role in gathering, analyzing, and disseminating information to support decision-making and optimize production processes. Here are some specific areas where an MIS is applied in production management:

11.4.1. Production Planning and Scheduling: An MIS provides real-time data on production capacity, resource availability, and demand forecasts, enabling production managers to create effective production plans and schedules. It helps in optimizing the allocation of resources, managing production timelines, and ensuring timely delivery of products.

11.4.2. Inventory Management: MIS provides accurate and up-to-date information on inventory levels, raw material availability, and production orders. It enables production managers to monitor inventory status, forecast demand, and make informed decisions regarding inventory replenishment and order fulfillment.

11.4.3. Quality Control: MIS facilitates the monitoring and analysis of quality-related data throughout the production process. It helps track key quality metrics, identify quality issues or defects, and take corrective actions. MIS can also integrate quality control data from various sources, such as inspection reports, test results, and customer feedback.

11.4.4. Performance Monitoring: An MIS tracks and measures production performance metrics, such as production output, cycle time, machine utilization, and downtime. It provides real-time visibility into production performance, enabling managers to identify bottlenecks, analyze efficiency, and implement process improvements to enhance overall productivity.

11.4.5. Supply Chain Management: MIS supports the coordination and integration of production activities within the broader supply chain. It facilitates data exchange and collaboration among suppliers, manufacturers, distributors, and customers. An MIS can provide visibility into supply chain dynamics, demand patterns, and inventory levels, enabling effective supply chain planning and coordination.

11.4.6. Reporting and Analysis: MIS generates reports and analytics that provide insights into production performance, resource utilization, production costs, and other key metrics. These reports help management in evaluating production efficiency, identifying areas for improvement, and making data-driven decisions. Advanced analytics and data visualization techniques can be utilized to gain deeper insights and support predictive modeling.

11.4.7. Continuous Improvement: An MIS can support continuous improvement initiatives, such as Lean manufacturing or Six Sigma, by providing data for analysis, tracking process improvements, and measuring the impact of changes on production performance. It facilitates the identification of waste, bottlenecks, and opportunities for process optimization.

11.5 Advantages of Management Information System (MIS) in Production Management

11.5.1. Enhanced Decision-Making: MIS provides accurate, timely, and relevant information to production managers, enabling them to make informed decisions regarding production planning, resource allocation, inventory management, and process improvement. It helps in optimizing production processes and improving overall operational efficiency.

11.5.2. Improved Visibility: An MIS provides real-time visibility into production activities, including production status, inventory levels, machine utilization, and quality metrics. This visibility allows production managers to monitor production performance, identify bottlenecks, and take proactive actions to address issues and optimize production flows.

11.5.3. Efficient Resource Management: MIS enables effective management of production resources, including materials, labor, and equipment. It helps in tracking resource availability, utilization, and performance, ensuring optimal resource allocation and minimizing wastage. This leads to improved efficiency and cost control.

11.5.4. Streamlined Communication and Collaboration: MIS facilitates effective communication and collaboration among various stakeholders involved in production management, including production managers, supervisors, operators, and suppliers. It enables the sharing of real-time information, updates, and instructions, promoting seamless coordination and teamwork.

11.5.5. Accurate Forecasting and Planning: An MIS provides historical data and trend analysis that support accurate demand forecasting and production planning. It helps in predicting customer demand, managing production schedules, and aligning production capacity with demand. This minimizes stockouts, improves customer satisfaction, and reduces inventory holding costs.

11.6 Disadvantages of Management Information System (MIS) in Production Management

11.6.1. Implementation and Maintenance Costs: Implementing an MIS in production management can involve significant upfront costs, including hardware, software, and system development. Additionally, ongoing maintenance and updates require continuous investments. Small-scale organizations may find it challenging to afford and sustain an MIS.

11.6.2. Data Integrity and Accuracy: An MIS relies on accurate and reliable data to provide meaningful insights. Inaccurate or incomplete data can lead to incorrect decision-making and adversely impact production processes. Data integrity and quality control measures need to be implemented and maintained to ensure data accuracy.

11.6.3. Resistance to Change and Training Needs: Introducing an MIS in production management may face resistance from employees who are accustomed to traditional manual processes. Resistance to change can hinder user adoption and utilization. Adequate training and change management strategies are necessary to overcome this challenge.

11.6.4. Data Security and Privacy Risks: An MIS involves the storage and processing of sensitive production-related data, such as inventory levels, production plans, and customer information. Ensuring data security and privacy protection is crucial to prevent unauthorized access, data breaches, or loss of critical information.

11.6.5. Dependency on Technology: An MIS heavily relies on technology infrastructure and systems. Any technical failures, system downtime, or disruptions can affect production operations and lead to delays or inefficiencies. Backup systems, redundancy measures, and disaster recovery plans need to be in place to minimize such risks.

It is important for organizations to carefully evaluate the advantages and disadvantages of implementing an MIS in production management. Proper planning, stakeholder involvement, and ongoing monitoring and improvement efforts are necessary to maximize the benefits and mitigate the potential drawbacks of an MIS.

11.7 Management Information System (MIS) in Material Management

A Management Information System (MIS) in material management is designed to support the efficient and effective management of materials, inventory, and related processes within an organization. Here are some key aspects of how an MIS can be utilized in material management:

11.7.1. Inventory Management: An MIS provides real-time visibility into inventory levels, stock movements, and item details. It facilitates accurate tracking of material quantities, locations, and availability. With this information, material managers can optimize inventory levels, reduce carrying costs, and avoid stockouts or overstock situations.

11.7.2. Demand Forecasting and Planning: An MIS in material management aids in analyzing historical demand patterns, sales data, and market trends. This data can be used to forecast future demand, enabling better planning and procurement decisions. The MIS can generate demand forecasts, which assist in determining the required material quantities and timing for procurement.

11.7.3. Supplier Management: An MIS can support the management of supplier information, contracts, and performance metrics. It provides data on supplier reliability, quality, delivery times, and pricing. Material managers can use this information to evaluate supplier performance, negotiate contracts, and make informed decisions about supplier selection and relationships.

11.7.4. Purchase Order Processing: An MIS streamlines the purchase order process by automating the creation, approval, and tracking of purchase orders. It helps manage purchase requisitions, supplier quotations, and order status updates. This improves procurement efficiency, reduces errors, and ensures timely delivery of materials.

11.7.5. Material Tracking and Traceability: An MIS enables tracking and traceability of materials throughout the supply chain. It records information about material origins, suppliers, batch numbers, expiration dates, and other relevant details. This is particularly valuable for industries with regulatory requirements, such as pharmaceuticals or food, where tracking the movement and quality of materials is essential.

11.7.6. Performance Measurement: An MIS provides key performance indicators (KPIs) and metrics for material management. It tracks metrics such as inventory turnover, stock accuracy, fill rates, and order cycle times. These metrics help in evaluating material management performance, identifying areas for improvement, and setting targets for operational efficiency.

11.7.7. Reporting and Analytics: An MIS generates reports, dashboards, and analytics that provide insights into material management processes. It enables data analysis, such as identifying slow-moving or obsolete inventory, monitoring supplier performance, or analyzing procurement costs. These insights support data-driven decision-making and continuous improvement efforts.

11.7.8. Integration with Enterprise Systems: An MIS in material management can be integrated with other enterprise systems, such as Enterprise Resource Planning (ERP) or

Warehouse Management Systems (WMS). This integration ensures data consistency and enables seamless information flow across different functional areas, such as finance, production, and logistics.

11.8 Advantages of Management Information System (MIS) in Material Management

11.8.1. Improved Inventory Control: An MIS provides accurate and real-time information about material levels, location, and movement. It enables organizations to have better control over their inventory, reducing the risk of stockouts, minimizing carrying costs, and optimizing inventory levels.

11.8.2. Efficient Procurement: With an MIS, organizations can automate and streamline the procurement process. It helps in generating purchase orders, tracking supplier performance, and ensuring timely delivery of materials. This improves procurement efficiency, reduces manual errors, and enhances supplier relationship management.

11.8.3. Enhanced Demand Forecasting: An MIS in material management facilitates data analysis and forecasting of material demand. It enables organizations to make accurate demand predictions, plan production schedules, and optimize inventory to meet customer demands. This reduces excess inventory and improves customer satisfaction.

11.8.4. Data-Driven Decision Making: An MIS provides meaningful reports, analytics, and key performance indicators (KPIs) related to material management. It enables organizations to make informed decisions based on accurate and up-to-date information. Data-driven decision making improves operational efficiency, cost control, and overall performance.

11.8.5. Streamlined Material Traceability: An MIS helps in tracking and tracing materials throughout the supply chain. It records information about material origins, suppliers, batch numbers, and expiration dates. This improves quality control, facilitates compliance with regulatory requirements, and enables effective product recalls, if necessary.

11.9 Disadvantages of Management Information System (MIS) in Material Management

11.9.1. Implementation and Maintenance Costs: Implementing an MIS in material management can involve significant upfront costs, including hardware, software, and system development. Ongoing maintenance, updates, and training requirements also add to the costs.

Organizations need to carefully evaluate the return on investment (ROI) before implementing an MIS.

11.9.2. Data Accuracy and Integration Challenges: An MIS relies on accurate and reliable data for effective material management. However, data accuracy and consistency can be challenging, especially when integrating data from multiple systems or sources. Ensuring data integrity and resolving data integration issues are critical to the success of the MIS.

11.9.3. Organizational Resistance and Training Needs: Implementing an MIS may face resistance from employees who are accustomed to manual or traditional processes. Resistance to change can hinder user adoption and utilization of the system. Adequate training and change management strategies are necessary to overcome this challenge.

11.9.4. Security and Privacy Risks: An MIS in material management involves the storage and processing of sensitive data, such as supplier information, pricing, and material specifications. Organizations need to implement robust security measures to protect against data breaches, unauthorized access, or loss of critical information.

11.9.5. Dependency on Technology: An MIS heavily relies on technology infrastructure and systems. Any technical failures, system downtime, or disruptions can affect material management processes and lead to operational delays. Organizations need to have backup systems, redundancy measures, and disaster recovery plans in place to minimize such risks.

While an MIS offers numerous advantages in material management, organizations need to carefully address the potential challenges and risks associated with its implementation. With proper planning, implementation, and continuous monitoring, an MIS can significantly improve material management processes, leading to increased efficiency, cost savings, and better customer satisfaction.

11.10 Summary

The manufacturing sector in India is a significant contributor to the country's economic growth and employment generation. With ongoing government initiatives and policy reforms, India aims to further strengthen its manufacturing capabilities and become a global manufacturing powerhouse. Technology has revolutionized the manufacturing sector, enhancing productivity, quality, and sustainability. Embracing and leveraging technology is essential for manufacturers to stay competitive in the global marketplace. An MIS in production management enhances visibility, efficiency, and decision-making by providing

accurate and timely information throughout the production process. It enables production managers to monitor, control, and optimize production activities, leading to improved productivity, quality, and customer satisfaction. An MIS in material management enhances visibility, efficiency, and control over materials and inventory-related processes. It supports accurate demand forecasting, optimized inventory levels, streamlined procurement, and effective supplier management. By leveraging an MIS, organizations can improve their material management practices, reduce costs, and enhance customer satisfaction.

11.11 Key Words

Automation and Robotics: Technology has enabled the automation of various manufacturing processes, minimizing human intervention and increasing efficiency. Robotics and robotic automation systems are used for tasks such as assembly, material handling, quality control, and packaging.

Internet of Things (IoT) and Connectivity: IoT technology allows the interconnectivity of machines, equipment, and systems in the manufacturing environment. This enables real-time monitoring, data collection, and analysis, leading to predictive maintenance, improved supply chain management, and better decision-making.

Additive Manufacturing (3D Printing): Additive manufacturing, commonly known as 3D printing, has revolutionized the manufacturing industry. It allows the creation of complex prototypes, customized products, and spare parts with greater flexibility and speed.

Advanced Materials and Nanotechnology: Technology has enabled the development and use of advanced materials in manufacturing. Nanotechnology, for instance, has led to the creation of stronger, lighter, and more durable materials with unique properties.

Artificial Intelligence (AI) and Machine Learning (ML): AI and ML technologies are increasingly employed in manufacturing for process optimization, quality control, predictive maintenance, and supply chain management.

Cloud Computing and Big Data Analytics: Cloud computing enables manufacturers to store and access large amounts of data securely. Big data analytics tools process this data, providing valuable insights for process optimization, quality improvement, demand forecasting, and customer behavior analysis.

11.12 Self-Assessment Questions

1. Write a note on manufacturing sector in India
2. What is the role of technology in manufacturing sector?
3. Explain the functions of management information system in production management

4. What are the advantages and disadvantages of MIS in production management?

5. Explain the functions of management information system in material management

6. What are the advantages and disadvantages of MIS in material management?

11.13 Suggested Readings

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LESSON- 12

MANAGEMENT INFORMATION SYSTEM IN SERVICE SECTOR

Learning Objectives

- ✓ To study the service sector in India
- ✓ To understand need for digitalization of service sector
- ✓ To examine the role of MIS in hotel management
- ✓ To know the advantages and disadvantages of MIS in hotel management
- ✓ To examine the role of MIS in banking management
- ✓ To know the advantages and disadvantages of MIS in banking management

Structure

12.1 Service Sector in India

The service sector in India has experienced significant growth and has emerged as a major contributor to the country's economy. It encompasses a wide range of industries and plays a crucial role in employment generation, GDP growth, and foreign exchange earnings. Here are some prominent service sector industries in India:

12.1.1. Information Technology (IT) and Information Technology Enabled Services (ITES): India has become a global hub for IT and ITES services. The country is known for its software development, IT consulting, business process outsourcing (BPO), and knowledge process outsourcing (KPO) services. Major cities like Bengaluru, Hyderabad, and Chennai are prominent IT hubs.

12.1.2. Banking, Financial Services, and Insurance (BFSI): The BFSI sector is a significant contributor to the Indian service sector. It includes commercial banking, investment banking, insurance, asset management, and other financial services. Many Indian banks and insurance companies have a strong presence both domestically and internationally.

12.1.3. Telecommunications and Mobile Services: The telecommunications industry has witnessed remarkable growth in India. It includes mobile services, internet service providers, telecommunication equipment manufacturing, and value-added services. India has one of the largest mobile user bases globally.

12.1.4. Tourism and Hospitality: The tourism and hospitality industry in India is a major source of revenue and employment. The country offers diverse attractions, including historical monuments, cultural heritage, wildlife, beaches, and medical tourism. It includes hotels, travel agencies, tour operators, restaurants, and transportation services.

12.1.5. Healthcare and Pharmaceutical Services: India has a robust healthcare sector that provides medical services, pharmaceutical manufacturing, clinical research, and telemedicine. The country is known for its cost-effective medical treatments and a large pool of skilled medical professionals.

12.1.6. Education and Training Services: The education sector in India has witnessed significant growth. It includes schools, colleges, universities, vocational training institutes, e-learning platforms, and coaching centers. India is a popular destination for international students seeking quality education.

12.1.7. Media and Entertainment: The media and entertainment industry in India encompasses television, film production, digital content creation, music, publishing, gaming, and advertising. Bollywood, India's Hindi film industry, is one of the largest in the world.

12.1.8. Professional Services: Professional services like legal services, accounting and auditing, consulting, market research, and human resources play a crucial role in the Indian service sector. These services cater to the needs of businesses and individuals.

12.1.9. Retail and E-commerce: The retail industry in India is experiencing significant growth, driven by organized retail, e-commerce platforms, and online marketplaces. The country has a vast consumer market, and both domestic and international retailers are expanding their presence in India.

12.1.10. Transportation and Logistics: The transportation and logistics sector supports the movement of goods and people across the country. It includes road transport, railways, aviation, shipping, warehousing, and logistics services.

12.2. Digitization of the Service Sector

The digitization of the service sector has been transformative, revolutionizing the way services are delivered, accessed, and consumed. It involves the integration of digital technologies and platforms to enhance service offerings, improve customer experiences, and streamline operations. Here are some key aspects of the digitization of the service sector:

12.2.1. Online Service Delivery: Digitization has enabled the shift from traditional brick-and-mortar service delivery models to online platforms. Service providers now offer their services through websites, mobile apps, and online platforms. This allows customers to access services conveniently from anywhere and at any time.

12.2.2. E-commerce and Online Marketplaces: The digitization of the service sector has facilitated the growth of e-commerce and online marketplaces. Customers can purchase services online, compare options, read reviews, and make informed decisions. Service providers benefit from the increased reach and access to a broader customer base.

12.2.3. Mobile Apps: Mobile apps have become a popular medium for service delivery and access. Service providers develop mobile apps that offer convenient and personalized experiences to customers. Mobile apps enable service booking, appointment scheduling, payment processing, and real-time communication.

12.2.4. Automation and Self-Service: Digitization has led to the automation of service processes and the introduction of self-service options. Customers can now complete tasks and access information independently using digital platforms. This reduces the need for manual intervention and speeds up service delivery.

12.2.5. Data Analytics and Personalization: Digitization allows service providers to collect and analyze vast amounts of customer data. Data analytics techniques help in understanding customer preferences, behavior, and needs. This enables personalized service offerings, targeted marketing, and improved customer experiences.

12.2.6. Chatbots and Virtual Assistants: Chatbots and virtual assistants are becoming increasingly prevalent in the service sector. They provide automated responses, answer

customer queries, offer recommendations, and assist in service interactions. These AI-powered tools enhance customer support and engagement.

12.2.7. Remote and Virtual Services: The digitization of the service sector has enabled remote service delivery through teleconferencing, video calls, and virtual collaboration tools. This is particularly relevant in sectors such as healthcare, education, consulting, and professional services. Remote services provide convenience, cost savings, and broader access to expertise.

12.2.8. Cloud Computing and Data Storage: Cloud computing allows service providers to store, access, and process data securely. Cloud-based service platforms offer scalability, flexibility, and cost efficiency. Service providers can leverage cloud infrastructure for data storage, software applications, and collaboration.

12.2.9. Online Payments and Digital Wallets: Digitization has revolutionized payment systems in the service sector. Customers can make online payments through various digital payment platforms and mobile wallets. This eliminates the need for cash transactions, enhances security, and provides convenience.

12.2.10. Feedback and Reviews: Digitization enables customers to provide feedback, ratings, and reviews for services through online platforms. This feedback mechanism helps service providers to understand customer satisfaction levels, identify areas for improvement, and enhance service quality.

The digitization of the service sector has opened-up new opportunities for service providers and enhanced customer experiences. Embracing digital technologies and platforms is essential for service businesses to stay competitive, adapt to evolving customer preferences, and improve operational efficiency.

12.3 Nature of Management Information System in the Service Sector:

The nature of an MIS in the service sector is characterized by the following key aspects:

12.3.1. Information Intensity: The service sector heavily relies on information to deliver services effectively. Information related to customer preferences, demand patterns, service quality, and operational efficiency is critical for decision-making and improving service delivery.

12.3.2. Customer Focus: The service sector is customer-centric, and an MIS helps capture, store, and analyze customer data, enabling personalized service delivery, targeted marketing, and enhanced customer satisfaction.

12.3.3. Process Orientation: Services are often intangible and delivered through complex processes. An MIS helps in managing and monitoring these processes, ensuring efficiency, quality control, and timely service delivery.

12.3.4. Dynamic Environment: The service sector operates in a dynamic and rapidly changing environment. An MIS provides real-time data, enables quick adaptation to market trends, and supports agile decision-making to respond effectively to changing customer needs and competitive forces.

12.4 Scope of Management Information System in the Service Sector:

The scope of an MIS in the service sector is broad and encompasses various areas, including:

12.4.1. Customer Relationship Management (CRM): An MIS facilitates effective CRM by managing customer data, preferences, and interactions. It enables personalized service, customer retention, targeted marketing campaigns, and loyalty program management.

12.4.2. Service Delivery and Operations Management: An MIS supports efficient service delivery by managing scheduling, resource allocation, and process optimization. It helps streamline operations, improve productivity, and enhance service quality.

12.4.3. Marketing and Sales Management: An MIS aids in market analysis, identifying customer segments, tracking marketing campaigns, and measuring their effectiveness. It supports sales forecasting, pricing strategies, and customer acquisition efforts.

12.4.4. Human Resource Management: An MIS assists in managing employee data, performance evaluations, training programs, and workforce planning. It improves HR processes, enables efficient staffing, and enhances employee engagement.

12.4.5. Financial Management: An MIS supports financial analysis, budgeting, and forecasting in the service sector. It aids in revenue management, cost control, profitability analysis, and financial reporting.

12.5 Significance of Management Information System in the Service Sector:

The significance of an MIS in the service sector can be summarized as follows:

12.5.1. Improved Decision-Making: An MIS provides accurate and timely information, enabling managers to make informed decisions. It supports data-driven decision-making, helping to optimize resource allocation, service offerings, pricing strategies, and market positioning.

12.5.2. Enhanced Operational Efficiency: An MIS automates routine tasks, streamlines processes, and reduces manual errors. It improves operational efficiency, leading to cost savings, faster service delivery, and better resource utilization.

12.5.3. Customer Satisfaction: An MIS helps in understanding customer preferences, tracking their interactions, and providing personalized services. It enhances customer satisfaction by delivering tailored experiences, resolving issues promptly, and maintaining strong customer relationships.

12.5.4. Competitive Advantage: An efficient MIS enables service organizations to respond quickly to market changes, customer demands, and competitive forces. It provides a competitive advantage by facilitating innovation, agility, and superior service delivery.

12.5.5. Performance Measurement and Analysis: An MIS generates comprehensive reports and analytics, enabling performance measurement and evaluation. It helps monitor key performance indicators, identify areas for improvement, and measure the effectiveness of strategies.

12.5.6. Compliance and Risk Management: An MIS supports regulatory compliance in the service sector, such as data privacy regulations and industry-specific requirements. It aids in risk identification, assessment, and mitigation.

12.6 Management Information System (MIS) in Hotel Management

A Management Information System (MIS) in hotel management refers to the use of technology and systems to gather, store, analyze, and report relevant information to support decision-making and improve operations within a hotel or hospitality establishment. An MIS in hotel management typically encompasses various software applications and hardware infrastructure that are specifically designed to meet the unique needs of the hospitality industry.

Here are some key components and functionalities of a Management Information System in hotel management:

12.6.1. Property Management System (PMS): A PMS is the core software system used to manage hotel operations, including reservations, check-ins, check-outs, guest profiles, room assignments, billing, and more. It serves as a central hub for data related to guest services, room availability, and revenue management.

12.6.2. Point of Sale (POS) System: A POS system is utilized in various areas of the hotel, such as restaurants, bars, gift shops, and other retail outlets. It enables efficient and accurate transaction processing, inventory management, and sales reporting.

12.6.3. Revenue Management System (RMS): An RMS helps optimize pricing and revenue strategies by analyzing market demand, competitor rates, historical data, and other factors. It provides insights and recommendations for setting room rates, managing occupancy levels, and maximizing revenue.

12.6.4. Customer Relationship Management (CRM) System: A CRM system helps manage guest interactions and relationships throughout their stay and beyond. It stores guest information, preferences, and history, enabling personalized services, targeted marketing campaigns, and loyalty program management.

12.6.5. Reporting and Analytics: MIS in hotel management includes reporting and analytics capabilities to extract meaningful insights from the data collected. Reports can cover various aspects, including occupancy rates, revenue, guest satisfaction, operational efficiency, and financial performance. Analytical tools aid in identifying trends, patterns, and opportunities for improvement.

12.6.6. Online Booking Engine: An online booking engine integrated with the hotel's website enables guests to make reservations directly. It provides real-time availability, room descriptions, rates, and secure payment processing, enhancing the booking experience and reducing reliance on third-party booking channels.

12.6.7. Channel Management System: To effectively manage distribution across multiple online travel agencies (OTAs), global distribution systems (GDS), and other booking channels, a channel management system is employed. It helps synchronize room availability, rates, and inventory, minimizing the risk of overbooking and streamlining online distribution.

12.6.8. Mobile Apps and Self-Service Kiosks: Some hotels employ mobile apps and self-service kiosks to enhance guest convenience and streamline operations. These technologies

allow guests to check-in, access room keys, request services, and perform various other tasks independently, reducing wait times and enhancing the overall guest experience.

12.7 Advantages of a Management Information System (MIS) in Hotel Management:

12.7.1. Improved Decision-Making: MIS provides real-time and accurate data, enabling managers to make informed decisions regarding room rates, inventory management, marketing strategies, and resource allocation. It enhances efficiency and reduces the reliance on guesswork or intuition.

12.7.2. Enhanced Operational Efficiency: MIS automates and streamlines various hotel operations, such as reservations, check-ins, check-outs, billing, and inventory management. It reduces manual errors, saves time, and improves overall efficiency, allowing staff to focus on providing better guest experiences.

12.7.3. Better Guest Service: MIS helps store and track guest preferences, enabling personalized services and anticipating guest needs. It facilitates efficient communication among hotel departments, ensuring smooth coordination and prompt resolution of guest requests or issues.

12.7.4. Revenue Optimization: MIS provides tools for revenue management and analysis, allowing hotels to optimize pricing strategies, manage occupancy levels, and identify revenue opportunities. It helps maximize revenue and profitability by considering factors such as market demand, competitor rates, and historical data.

12.7.5. Data Analysis and Reporting: MIS generates comprehensive reports and analytics, providing insights into various performance metrics, including occupancy rates, revenue, guest satisfaction, and operational efficiency. It enables managers to identify trends, evaluate the effectiveness of strategies, and make data-driven decisions.

12.7.6. Integration with Online Channels: MIS integrates with online booking engines, channel management systems, and OTAs, enabling real-time availability updates, centralized reservation management, and seamless distribution across multiple platforms. It expands the hotel's reach, increases online visibility, and improves booking processes.

12.8 Disadvantages of a Management Information System (MIS) in Hotel Management:

12.8.1. Cost: Implementing and maintaining an MIS can involve significant costs, including software licenses, hardware infrastructure, staff training, and ongoing support. For smaller hotels with limited budgets, the initial investment may be challenging.

12.8.2. Complexity: MIS implementation requires careful planning, system configuration, and staff training. It can be complex and time-consuming, especially when integrating multiple systems and ensuring data accuracy and consistency across platforms.

12.8.3. Technical Challenges: Hotels may face technical issues, such as system downtime, software glitches, compatibility problems, or cybersecurity risks. These challenges can disrupt operations and require IT expertise to address promptly.

12.8.4. Staff Resistance: Introducing new technology and systems may encounter resistance from employees who are unfamiliar or uncomfortable with the changes. Staff training and effective change management strategies are necessary to overcome resistance and ensure successful adoption.

12.8.5. Data Privacy and Security: MIS involves storing and processing sensitive guest information, such as personal details and payment data. Hotels must implement robust data protection measures and comply with privacy regulations to safeguard guest information and prevent data breaches.

12.8.6. Overreliance on Technology: While MIS offers numerous benefits, overreliance on technology can result in a lack of personal interaction and personalized service. Hotels must strike a balance between automation and maintaining a human touch to provide exceptional guest experiences.

It is important to note that the advantages and disadvantages can vary depending on the specific MIS implementation, the size and type of hotel, and the expertise of the staff managing the system.

12.9 Management Information System (MIS) in Banking Management

A Management Information System (MIS) in banking management refers to the use of technology and systems to gather, store, analyze, and report relevant information to support

decision-making and improve operations within a bank or financial institution. An MIS in banking management typically encompasses various software applications and hardware infrastructure that are specifically designed to meet the unique needs of the banking industry.

Here are some key components and functionalities of a Management Information System in banking management:

12.9.1. Core Banking System: The core banking system forms the backbone of an MIS in banking. It manages the core banking operations, such as customer accounts, deposits, loans, transactions, and payments. It integrates various banking functions and provides a centralized database for accurate and up-to-date customer and account information.

12.9.2. Customer Relationship Management (CRM) System: A CRM system in banking helps manage customer interactions and relationships. It stores customer profiles, transaction histories, preferences, and communication logs. It enables personalized service delivery, targeted marketing campaigns, and customer retention initiatives.

12.9.3. Risk Management System: A risk management system helps identify, assess, and mitigate risks associated with lending, investment, compliance, and operational activities. It provides tools for risk measurement, monitoring, reporting, and compliance with regulatory requirements.

12.9.4. Fraud Detection and Prevention: An MIS in banking incorporates fraud detection and prevention tools to identify suspicious activities, monitor transactions, and prevent fraudulent actions. It employs algorithms and artificial intelligence to detect anomalies and potential fraud patterns.

12.9.5. Reporting and Analytics: MIS in banking management includes robust reporting and analytics capabilities to extract meaningful insights from the data collected. Reports can cover various aspects, including financial performance, customer behavior, market trends, and risk analysis. Analytics tools aid in decision-making, strategy formulation, and performance evaluation.

12.9.6. Online and Mobile Banking: MIS supports online and mobile banking platforms, enabling customers to access their accounts, make transactions, and perform various banking activities remotely. It ensures secure and convenient digital banking experiences for customers, contributing to operational efficiency and customer satisfaction.

12.9.7. Compliance and Regulatory Reporting: Banks operate in a heavily regulated environment. MIS helps automate compliance processes and regulatory reporting, ensuring adherence to regulatory requirements, such as anti-money laundering (AML), know your customer (KYC), and Basel III guidelines.

12.9.8. Treasury and Asset Liability Management: MIS incorporates treasury and asset liability management (ALM) systems to manage the bank's investments, liquidity, interest rate risk, and balance sheet optimization. It provides tools for monitoring market conditions, analyzing investment options, and managing treasury operations.

12.10 Advantages of a Management Information System (MIS) in Banking Management:

12.10.1.Improved Decision-Making: MIS provides accurate and real-time data, enabling bank managers to make informed decisions regarding risk management, product development, marketing strategies, and resource allocation. It enhances decision-making by providing comprehensive insights and reducing reliance on guesswork.

12.10.2.Enhanced Operational Efficiency: MIS automates and streamlines various banking processes, such as customer onboarding, account management, loan processing, and transaction monitoring. It reduces manual errors, saves time, and improves overall operational efficiency, allowing staff to focus on value-added activities.

12.10.3.Better Customer Service: MIS stores and tracks customer data, transaction histories, and preferences. It enables personalized service delivery, targeted marketing, and efficient query handling. Bank staff can access comprehensive customer information, enabling them to provide customized solutions and enhance customer satisfaction.

12.10.4.Risk Management and Compliance: MIS supports risk management by providing tools for risk identification, measurement, and mitigation. It helps banks comply with regulatory requirements by automating compliance processes and generating accurate and timely reports. It aids in detecting and preventing fraudulent activities through advanced analytics and monitoring tools.

12.10.5.Data Analysis and Reporting: MIS generates comprehensive reports and analytics, providing insights into various performance metrics, including financial performance, customer behavior, and market trends. It enables bank managers to identify patterns, evaluate

strategies, and make data-driven decisions. The system can also generate regulatory reports efficiently, saving time and effort.

12.10.6.Improved Security: MIS incorporates security measures to protect sensitive customer information, such as encryption, access controls, and data backup. It helps prevent unauthorized access, ensures data integrity, and safeguards against cybersecurity threats.

12.11 Disadvantages of a Management Information System (MIS) in Banking Management:

12.11.1.Cost: Implementing and maintaining an MIS involves significant costs, including software licenses, hardware infrastructure, data storage, and ongoing system updates. For smaller banks or financial institutions with limited budgets, the initial investment may be challenging.

12.11.2.Complexity: Implementing an MIS requires careful planning, system configuration, and staff training. The integration of various systems and ensuring data accuracy and consistency can be complex and time-consuming.

12.11.3.Technical Challenges: Banks may encounter technical issues, such as system downtime, software glitches, or compatibility problems between different systems. These challenges can disrupt operations and require technical expertise to address promptly.

12.11.4.Data Privacy and Security Risks: The MIS in banking stores and processes large amounts of sensitive customer data. Banks must implement robust data protection measures and comply with data privacy regulations to prevent data breaches or unauthorized access. Failure to do so can lead to reputational damage and legal repercussions.

12.11.5.Staff Resistance and Training: Introducing new technology and systems may encounter resistance from employees who are unfamiliar with or resistant to change. Proper staff training and change management strategies are essential to ensure successful adoption and maximize the benefits of the MIS.

12.11.6.Dependency on Technology: Overreliance on technology can result in a lack of personal interaction and personalized service, which may negatively impact customer relationships. Banks must balance automation with maintaining a human touch to provide exceptional customer experiences.

It's important to note that the advantages and disadvantages can vary depending on the specific MIS implementation, the size and type of the bank or financial institution, and the expertise of the staff managing the system. Banks need to carefully evaluate the costs, benefits, and risks associated with implementing an MIS to make informed decisions.

12.12 Summary

The service sector is diverse and continually evolving, contributing to India's economic growth and development.A Management Information System (MIS) in the service sector refers to the use of technology, software, and systems to gather, process, store, and disseminate information within service-based organizations. It encompasses various applications and tools that help streamline operations, enhance customer service, and support decision-making in industries such as healthcare, hospitality, banking, transportation, retail, and more.The integration and utilization of advanced systems within a hotel's operations provide a comprehensive management information system, enabling hotel managers to make informed decisions, streamline processes, improve guest satisfaction, optimize revenue, and enhance overall operational efficiency.The integration and utilization of advanced systems within a bank's operations provide a comprehensive management information system, enabling bank managers to make informed decisions, streamline processes, enhance risk management, improve customer service, and ensure regulatory compliance.

12.13 Key Words

Information Technology (IT) and Information Technology Enabled Services (ITES): India has become a global hub for IT and ITES services. The country is known for its software development, IT consulting, business process outsourcing (BPO), and knowledge process outsourcing (KPO) services. Major cities like Bengaluru, Hyderabad, and Chennai are prominent IT hubs.

Banking, Financial Services, and Insurance (BFSI): The BFSI sector is a significant contributor to the Indian service sector. It includes commercial banking, investment banking, insurance, asset management, and other financial services. Many Indian banks and insurance companies have a strong presence both domestically and internationally.

Telecommunications and Mobile Services: The telecommunications industry has witnessed remarkable growth in India. It includes mobile services, internet service providers, telecommunication equipment manufacturing, and value-added services. India has one of the largest mobile user bases globally.

Tourism and Hospitality: The tourism and hospitality industry in India is a major source of revenue and employment. The country offers diverse attractions, including historical monuments, cultural heritage, wildlife, beaches, and medical tourism. It includes hotels, travel agencies, tour operators, restaurants, and transportation services.

Healthcare and Pharmaceutical Services: India has a robust healthcare sector that provides medical services, pharmaceutical manufacturing, clinical research, and telemedicine. The country is known for its cost-effective medical treatments and a large pool of skilled medical professionals.

Education and Training Services: The education sector in India has witnessed significant growth. It includes schools, colleges, universities, vocational training institutes, e-learning platforms, and coaching centers. India is a popular destination for international students seeking quality education.

Media and Entertainment: The media and entertainment industry in India encompasses television, film production, digital content creation, music, publishing, gaming, and advertising. Bollywood, India's Hindi film industry, is one of the largest in the world.

12.14 Self-Assessment Questions

1. Write a note on service sector in India
2. What is the need for digitalization of service sector?
3. Explain nature, scope, and significance of MIS in service sector
4. what are the functions of MIS in hotel management?
5. Explain the advantages and disadvantages of MIS in hotel management
6. what are the functions of MIS in banking management?
7. Explain the advantages and disadvantages of MIS in banking management

12.15 Suggested Readings

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Dr.K.Madhu Babu

LESSON -13

MANAGER'S ROLE IN DECISION MAKING

Learning Objectives

- ✓ To Know the Decision Making for Attracting and Retaining the employees
- ✓ To Understand the Types of decision-making in management
- ✓ To Discuss the Decision Making steps
- ✓ To Analyze the types of Decisions
- ✓ To Learn the Traditional Factors influence the Decision Making
- ✓ To Study the New Factors influence the Decision Making

Structure

13.0 Introduction

Organizations are constantly changing the way they do business and these changes are largely brought about by advancements in digital technology. The integration of digital technology into business has materially changed how organizations operate and deliver value to the customers. It has allowed businesses to reach their customers faster, adapt to changing market forces, improve operational efficiency, and increase profitability, among other things.

An aftereffect of this dependence of businesses on technology is the growing significance of Information Technology (IT) and associated decision-making for the sustainability and competitiveness of organizations. Given the criticality of the decisions that the IT department takes, it is beneficial for decision-makers to have an understanding of the decision-making processes, methods, and factors that influence decisions**.**

The decision-making process in IT starts with the overall business requirement and continues with the development of policies, processes, systems, and applications to support those requirements. Since it is also primarily responsible for security and compliance, the IT department defines the architecture and is solely responsible for the implementation, maintenance, and operations of the systems infrastructure.

When we refer to decision making in HR, it means all people processes are involved. The decisions taken within this function or by it, cover the entire employee lifecycle from the time potential talent is identified, to the hiring, performance management, compensation and

exit. HR relies on market data as well as internal feedback and insights, to enable faster and better decision making. For example, compensation increases are not linked only to how the company has performed, but also to how the jobs are being paid, size of the jobs and difference in the pay as compared to the external market. These aspects are part of HR's role.

The decision making impacts all business processes. Unlike what was earlier believed, HR is truly a business partner now. Its decisions have a direct implication for all the businesses that the company operates in. For example, there is a need for new skills that are coming up for an upcoming business project. HR will be responsible for creating the Skills Matrix which in turn will impact the big decision of whether to build it internally or buy it externally. These are key business decisions which are driven by the practitioners in Human Resource Management.

13.1 Attracting and Retaining Employees

Competition is faced by HR officials too. Firms of all sizes must compete with each other for recruiting a suitable workforce for their companies. The human resource department is responsible for this and they must adopt various methods for luring top talents that are available. But the competition doesn't stop with recruiting. Good employees are constantly being tempted by other enterprises with better salaries and benefits. The online HR IIM Raipur course teaches you that retention of people is the toughest challenge that companies face today.

13.2 Managing Change

Change is inevitable in a fast-paced industrial climate. There are different kinds of transitions that an organization must go through. There could be technological, managerial, geographical, or other variations. Technological developments are what will affect employees the most. Many staff members may not be able to accept them and adapt to them. An online program in HR could be due to the workers' mentality, lack of skills, or training. But companies cannot progress unless people progress. It is the human resource department that must handle such a challenge.

13.3 Training and Upskilling

The pace at which technology advances makes it difficult for companies to manage. But without integrating such developments, beating competition is not possible. It is essential to adopt all modern advancements to ensure the successful functioning of the firm. But employees must also have the skills to work with new tools. Online HR IIM Raipur stresses the need to constantly upskill individuals so that they can work efficiently using new techniques. HR managers must see that all staff members are trained for their present and future responsibilities in the company.

13.4 Getting People Who Fit in Culturally

Different companies have different working styles and cultures. A firm with a tradition of employees arriving for work in formals cannot be suitable for someone who is used to attending office in denim and t-shirts. The culture of workplaces can also vary with industries. The online program in HR can tell how important it is to ensure that a new recruit is a cultural fit for your company. Unless it is so, that person is sure to be looking at the exit door constantly.

Decision-making in management is important because you may encounter situations where you have several options that may impact the workplace in different ways. They may affect employees, other members of management or the company's reputation. Here are some other reasons why decision-making in management is important:

Ensuring the company keeps growing: You might make critical decisions that ensure your workplace continues growing, like making financial decisions.

Choosing business partners: Management may decide on valuable business partners, like suppliers or stakeholders, that your workplace may partner with to bring in a higher amount of profit.

Choosing effective operations and strategies: You can decide on effective strategies and operations to optimize efficiency and reach workplace goals.

13.5 Types of decision-making in management

Here are the three types of decision-making that you may encounter in management:

13.5.1 Avoiding

The avoiding decision-making style allows members of management to not make a choice, rather than choosing from the present options. You may choose this style of decision-making if you don't have enough information to make an informed decision. Instead, you may decide to wait for more alternative choices to present themselves before making coming to a decision.

It's important to have your workplace's best interest in mind while determining the right choice, so you may also keep from making a decision if the potential outcomes may cause more harm to your organization than good. Lastly, you may choose not to make a decision if there is not an urgent need for change. For example, if you're deciding on a new attendance policy for employees, you might decide to stick with the existing policy if employee attendance isn't a pressing issue in your workplace.

13.5.2 Problem-seeking

Problem-seeking involves making decisions based on estimations or possible future events. Management may use this style of decision-making when finding proactive ways to keep potential issues from happening. When doing so, you might make decisions based on the outcomes of previous challenges in your workplace.

13.5.3 Problem-solving

A problem-solving decision-making style allows for management to create solutions to issues that exist within the workplace. This is a common style of decision-making, since a key role of management involves resolving workplace issues to improve workflow and create a positive environment for team members. You might make problem-solving decisions when an employee comes to you with an issue, or when an obstacle arises that lowers productivity.

13.6 Decision-making steps

Here are the steps in the decision-making process to help you identify your available choices and make an informed choice as a manager:

13.6.1. Recognize the issue

The first step in the decision-making process involves recognizing an issue or opportunity for change. Consider what elements of your workplace where you can implement changes that lead to improvement. If addressing an issue, determine the cause of the issue so that you may understand how it can affect your workplace in the future. If you're looking for opportunities for improved operations or workflow, consider speaking with your team members to understand their ideas for improvement.

13.6.2. Gather relevant information

The second step involves gathering information to help you make a well-informed decision. Try to gather facts and data that include numbers, so that you may compare statistics. For example, if deciding on new sales processes, you may review the sales numbers from previous quarters to see which strategies generated the most profit. Communicate with your team members that may provide valuable information about the decision.

13.6.3. Create a list of options

Next, create a list of options that can benefit your workplace. Try to develop a wide range of options so that you have many alternatives from which to choose. Consider consulting with team members for decision-related suggestions. Be sure to write the list on a document so that you may save it and refer back to it as you continue through the decision-making process. When creating your list, include the following information:

A description of the option: Describe each option, including which staff members the decision may affect, and what materials, budget or resources your workplace may require to make the decision happen.

Potential outcomes: Describe the potential outcomes for each option, including the benefits and challenges.

Second options: Consider including information about a second option that you may pursue if the first decision doesn't have the desired outcome.

13.6.4. Consider your options carefully

After creating your list of options, consider each carefully before making your decision. Here are some elements that you may consider while evaluating your choices:

13.6.4(a) Feasibility: This determines if a decision is convenient and practical for the workplace. If a decision is feasible, then you may make the changes easily and the transition may go smoothly.

13.6.4(b) Acceptability: This measures how well staff members may accept the decision and adapt to the change. To better understand acceptability, you might consult with team members to understand their opinions on each option.

13.6.4(c) Sustainability: This refers to the long-term effects that the decision's outcome may have on your workplace, and if the company is able to sustain the change for an extended period of time.

13.6.5. Make your decision

After reviewing all available options, it's time to make the decision that is a good choice for your workplace. Make the decision that best matches your workplace's needs. Then, you can create a plan to implement the changes into your workplace. To do so, be sure to inform staff members of the change and explain how it may impact them. Address any concerns or questions that they may have.

13.6.6. Review your choice

After making your decision and implementing the necessary changes, take time to review the impact of your choice. Determine how it impacted employees and other members of management. You might request employees to provide you with feedback on the decision, or you may review data for a period of time after making the decision. This may help you better understand the outcome of your choice. For example, if you decided to change your

company's marketing strategies to lower expenses, you might review your workplace's budget to better understand the money that it saved because of your decision.

13.7 Identify your goals

Try to identify the goals that you want your team to achieve. When making decisions, you may review your goals to see if any of the available options may impact your objectives. For example, if you have a goal of growing your team to contain 25 people, then you might make a decision to hire new employees until you achieve your goal.

13.8Align your decisions with your workplace's values

You might make decisions that correspond to your workplace's values so that the company's reputation remains positive, rather than making a decision that may make the company seem withdrawn from its core values. As a member of management, try to consider which option may best align the company's values and beliefs. For example, if your workplace values teamwork, you might focus on making decisions that result in improved collaboration or team-building.

Be flexible

This may encounter a decision that doesn't have the desired outcome. As a leader in your workplace, it's important to adapt to the change and have a second option available if the first option doesn't work out as you planned it. Try to be flexible and set a positive example to your team members by using problem-solving skills to choose an alternative option.

13.9 Types of Decision

The importance of models for decision-makers

Decision-making models can help teams simplify their decision-making processes and collaborate more effectively. Models provide useful steps for teams to follow to create solutions and describe their processes clearly to other team members.

When everyone on a team understands the decision-making model being used, they can more easily contribute to the thinking process and together, reach a balanced, successful solution.

As a decision-maker, to help you understand when to use some common decision-making models, examine the definitions and steps below:

13.9.1. Rational decision model

The rational decision-making model focuses on using logical steps to come to the best solution possible. This often involves analyzing multiple solutions at once to choose the one that offers the best quality outcome.

Teams typically use the rational decision model when they have time for meetings and research, which allows them to create a list of potential solutions and discuss the pros and cons of each. Here are the steps you may follow when using a rational decision-making model:

13.9.1(a) Define your goal or obstacle: First, you must define the goal or obstacle you wish to achieve or overcome. Defining this helps you understand exactly what outcome your solution should produce.

13.9.1(b) Determine the relevant information: For this step, consider delegating research tasks to your team or brainstorming during a team meeting. Determine what information about your goal or obstacle is relevant to finding a solution.

13.9.1(c) Create a list of options: Using the relevant information, your team can create a list of potential options for solutions. Try to support your options with evidence for why they would solve achieve your goal or overcome your obstacle.

13.9.1(d) Arrange options by their value: After creating a list of options, arrange them by their likelihood of success. Options that have a higher chance of success also have a higher value, while options with little evidence may have a lower value.

13.9.1(e) Choose the best option: Consider the value of each option and how it can help your company succeed. With your team, come to a consensus about the best option for a solution using the information you've gathered.

13.9.1(f) Finalize your decision and take action: Once your team decides on the best solution, clearly state your commitment to the solution and ask if any team members have concerns. After this, you can implement your solution in your company.

13.9.2. Intuitive decision model

Rather than logical reasoning, the intuitive decision model uses feelings and instinct to make decisions. Often, team leaders or managers use this model to make quick decisions when they don't have a lot of time for research or planning.

The process of an intuitive decision is less structured and may use previous knowledge of similar goals or obstacles to determine a useful solution. Consider the following steps to help you use the intuitive decision-making model:

13.9.2(a)Define your goal or obstacle: Even with little time, it's important to define your goal or obstacle clearly, especially if you're making a decision without your team. This can help you explain the decision and its effects later.

13.9.2(b)Identify similar goals or obstacles: Brainstorm similar goals or obstacles you've encountered before and how you solved them. Use this information as a basis for creating your own solution.

13.9.2(c)Recognize possible biases: Recognizing your biases is especially important when you don't have input from your team. Consider how your decision may affect yourself, your team and your company as you think of potential solutions.

13.9.2(d)Determine a usable solution: Determine the best solution using your prior experience and the values of your company. An ideal solution helps your company achieve its goals or overcome an obstacle while also benefitting your team and other employees.

13.9.2(e)Finalize your decision and take action: After choosing a usable solution, you can alert your company and team of your decision. If you have to make the decision quickly, you may have to put it into action without discussing with your team.

13.9.3. Recognition-primed decision model

The recognition-primed decision model, created by Gary A. Klein in his book "Sources of Power," uses quick thinking and prior experience to make decisions, often in fast-paced environments.

Team leaders may use this model to assess the basics of a situation and create a potential solution and then think through the solution to determine if it's usable. This may

require you to have a lot of experience with the goal or obstacle for you to create a suitable solution. The following steps can help you use a recognition-primed decision model:

13.9.3(a) Define your goal or obstacle: Clearly define the goal or obstacle your team wants to achieve or overcome to make it easier for you to create a solution quickly. While the idea can be broad, try to identify the most important thing you need to decide.

13.9.3(b) Consider relevant information and similar situations: Using your prior experience, quickly assess the situation and determine what information or prior situations can help you make a usable solution. If you have time, do more research on how to solve your goal or obstacle.

13.9.3(c) Create a potential solution: Create at least one potential solution using your prior experience or additional knowledge about the situation. To quicken your decision process, try to create a generic solution so you can change or add details as you think through it.

13.9.3(d) Consider if the solution works: Think through your solution to determine if it can really solve your challenge. Start by considering the most obvious issues and then consider the smaller details of the solution.

13.9.3(e) If needed, change the solution: Your first solution may not produce the best outcomes, so change details about it if you need to. This may involve adding new actions to your solution, making it more specific or changing it altogether.

13.9.3(f) Finalize your decision and take action: Once you're confident in your solution, finalize the decision with your team and take action. In a fast-paced situation, you may have to change your solution again if you learn new information while taking action.

13.10 Creative decision model

The creative decision model uses original ideas to create innovative solutions that achieve goals or overcome obstacles. This involves thinking through a situation and inventing a solution without referencing similar situations.

Often, you can use this model for situations you haven't experienced before, like new projects or production issues. Using the creative decision model typically requires flexible thinking to create successful, unique solutions. You may follow these steps when using the creative decision-making model:

13.10.(a)Define your goal or obstacle: You may not have experience with your goal or obstacle, so it's useful to define it as clearly as possible to help you understand what you need to do. This may involve meetings with your team or other colleagues, like business partners or managers.

13.10.(b)Consider relevant information: Do research on the challenge you need to solve to learn everything you can about it. This includes trying to find any similar projects, reports or companies that may inspire your ideas.

13.10.(c)Consider the information over time: You can choose how long to consider the information, but it's helpful to take at least a day to think about your challenge passively. To do this, you may brainstorm ideas, talk with colleagues or make a word-association list.

13.10(d)Create a usable solution: With the creative decision model, your idea may come naturally after a period of thinking about your goal or obstacle and the information relevant to it. Think through your solution logically to make sure it's usable for your situation.

13.10(e)Finalize your decision and take action: After considering the details of your solution, you may finalize your decision with your team and take action to solve your challenge. It's helpful to have a draft or presentation of your creative solution to explain it to your team more easily.

13.11 Traditional Factors Influencing It Decision-Making

Here are the five most important factors that have traditionally influenced decision-making in information technology:

13.11.1. Business Constraints

Business constraints such as stakeholder interests, organizational culture, etc. have a big influence on decision-making. Smaller organizations and startups are usually more consensus-driven but as they grow larger such a culture is difficult to maintain. Decisions in larger organizations are driven more by stakeholder interests. But, one business constraint that is uniformly applicable to organizations both small and large is regulatory compliance.

Regulatory compliance such as SOC, HIPAA, CCPA, etc. as well as standards such as ISO 27001 have a huge impact on an organization's decision-making. For example, healthcare organizations need to be HIPAA compliant. This compliance requirement factors in on their decisions on any process or tool impacting how they create, collect, or transmit Protected Health Information (PHI).

13.11.2. Resource Constraints

A resource is a broad term that encompasses anything required to conduct business. Financial or budgetary limitations, lack of access to a skilled workforce, lack of technical knowledge, etc. are common examples of resource constraints.

13.11.3. Time Constraints

The success of any decision is measured by its outcomes over a defined period of time. Therefore, time is a fundamental constraint applicable not only to decision-making but to every business endeavor.

13.11.4. Risk Appetite

How an organization perceives risk and how much risk it has tolerance for have a significant impact on its decision-making. Every business decision has some amount of risk associated with it and the risk appetite of the organization determines its risk treatment strategy. For example, risk-averse organizations make decisions that avoid risks while more adventurous organizations may opt for a risky decision with plans for risk mitigation.

13.11.5. Cognitive Biases

Cognitive biases impact our decision-making in all walks of life. These systematic biases brought about by pre-established beliefs, attitudes and values distort how we process and interpret information, introducing errors in our decision making.

For example, anchoring bias causes us to rely heavily on the first piece of information we receive about a topic. Such a bias can have a severe impact on project plans and estimates since it prevents us from objectively evaluating new information and updating our schedules and estimates based on the new information.

13.12 New Factors Influencing It Decision Making

As organizations transition conventional workloads to the cloud, increase reliance on SaaS applications, and transform work cultures with remote and hybrid offices, new factors that influence IT decision-making are coming into play.

13.12.1 Increasing Dependence On Technology

Organizations are increasingly becoming dependent on technology. Take for example video conferencing and how it went from being a luxury to an asset to a necessity. Today video conferencing technologies play an important role not only in digital communication but also in collaboration, onboarding, training, sales, and many more business functions.

The use of SaaS solutions has also experienced an exceptional growth spurt. Typically, organizations use hundreds of SaaS applications with each team or function having their own applications stack that serves them best given the parameters of their specific situation. The decision to adopt such SaaS solutions is increasingly being taken based on the productivity needs of the team while sidelining IT concerns.

IT decision-making needs to adapt to this growing trend and find workarounds for data and security challenges to avoid productivity roadblocks.

13.12.2 Changing Role of The IT Department

The logical conclusion from the previous section is that the role of the IT department is changing; it now is primarily a productivity enabler. Coming to terms with this growing reality means that IT departments need to give up their role as sole decision-makers and become more collaborative in their decision-making process.

13.12.3 Growing Expertise of End-Users

While the IT department does play a central role in the security and management of technology, it does not actually use most of the tools and applications adopted by the organization. The end-users, on the other hand, play a dominant role in the use of those tools and applications. Many of these end-users are often much more knowledgeable about the tools, applications, and technologies than those in the IT department. Therefore, they can play an important role in IT decision-making.

13.13Summary

A decision-making model describes the method a team will use to make decisions. The most important factor in successful decision-making is that every team member is clear about how a particular decision will be made. Who will be making the decision? How will team members be involved? Bywhen? Knowing these things allows team members to be fully informed participants in discussions - "Will we be giving input to the team leader so he can make the decision?" or "Will we need to discuss this topic and come to agreement during this meeting?"

Knowing how a particular decision will be made can also help a team plan their meeting agendas more effectively and lead to more collaborative team process. Most importantly, understanding how decisions will be made helps to build support for the final decision and active commitment to that decision's implementation. Because effective teams work towards the fullest participation of each member, teams often use some version of a consensus decision-making model. When used appropriately, this model of decision-making can maximize the quality of a team's decision

13.14 Key words

Decision Making

Decision-making models can help teams simplify their decision-making processes and collaborate more effectively. Models provide useful steps for teams to follow to create solutions and describe their processes clearly to other team members

Problem-solving

A problem-solving decision-making style allows for management to create solutions to issues that exist within the workplace

Problem seeking

Problem-seeking involves making decisions based on estimations or possible future events. Management may use this style of decision-making when finding proactive ways to keep potential issues from happening

Avoiding

The avoiding decision-making style allows members of management to not make a choice, rather than choosing from the present options

13.15 Self Assessment Questions

1. Discuss the Decision Making processfor Attracting and Retaining the employees

2. Describe the Types of Decision Making in management?

3. Briefly Discuss the steps in Decision Making

4. Explain the Traditional Factors influence the Decision Making

13.16 Suggested Readings

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LESSON -14

CONCEPTUAL MODEL OF DECISION MAKING

Learning objectives

- ✓ To Learn the various models of Decision Making
- ✓ To Know the Classical Model of Decision Making
- ✓ To Understand the Types of Decision
- ✓ To Analyse the Herbert Simon Models
- ✓ To Discuss the Group Decision Making Models

Structure

14.0 Introduction

A general theory of administration must include principles that will insure both correct decision making andeffective action (Simon, 1947). The task of "deciding" is fundamental toadministration, and there is a variety ofstrategies for deciding. The following descriptions

focus on contemporary views and concludes with a synthesis and contingency model of decision making in educational organizations.

14.1 The Classical Model: An Optimizing Strategy

Classical decision theory assumes that decisions should be completely rational and optimal; thus, the theory employs an optimizing strategy that seeks the best possible alternative to maximize the achievement of goals.

1. A problem is identified and framed.

2. Goals and objectives are established.

3. All the possible alternatives are generated.

4. The consequences of each alternative are evaluated in terms of goals.

5. The best alternative is selected—that is, the one that maximizes goal achievement.

6. Finally, the decision is implemented and evaluated.

The classical model is an ideal (a normative model), rather than a description of how administrators really make decisions. Most scholars consider the classical model an unrealistic ideal. Why?

Decision makers virtually never have access to all the relevant information.

Generating all the possible alternatives and their consequences is impossible.

The classic model assumes information-processing capacities, rationality, and knowledge that decisionmakers simply do not possess.

Although it may be an ideal, the classic model is not very useful to practicing administrators.

14.2 The Administrative Model: A Satisficing Strategy

The severe limitations of the classical model make more realistic conceptual approaches to decision makinginevitable. The complexity of problems and the limited capacity of the human mind prohibit the use of anoptimizing strategy on all but the simplest problems. Herbert Simon (1947) was the first to introduce anadministrative model of decision making to provide a more accurate description of the way administrators bothdo and should make organizational decisions. The basic approach is satisficing—that is, finding a satisfactoryand sufficient solution rather than the best one. The satisficing decision-action-cycle includes the followingsteps. The administrator must:

1. Recognize a problem and then frame it and define it clearly and concisely.

2. Analyze the problem by examining relevant data.

3. Before proceeding: Establish criteria for success—outcomes that are satisfactory and sufficient.

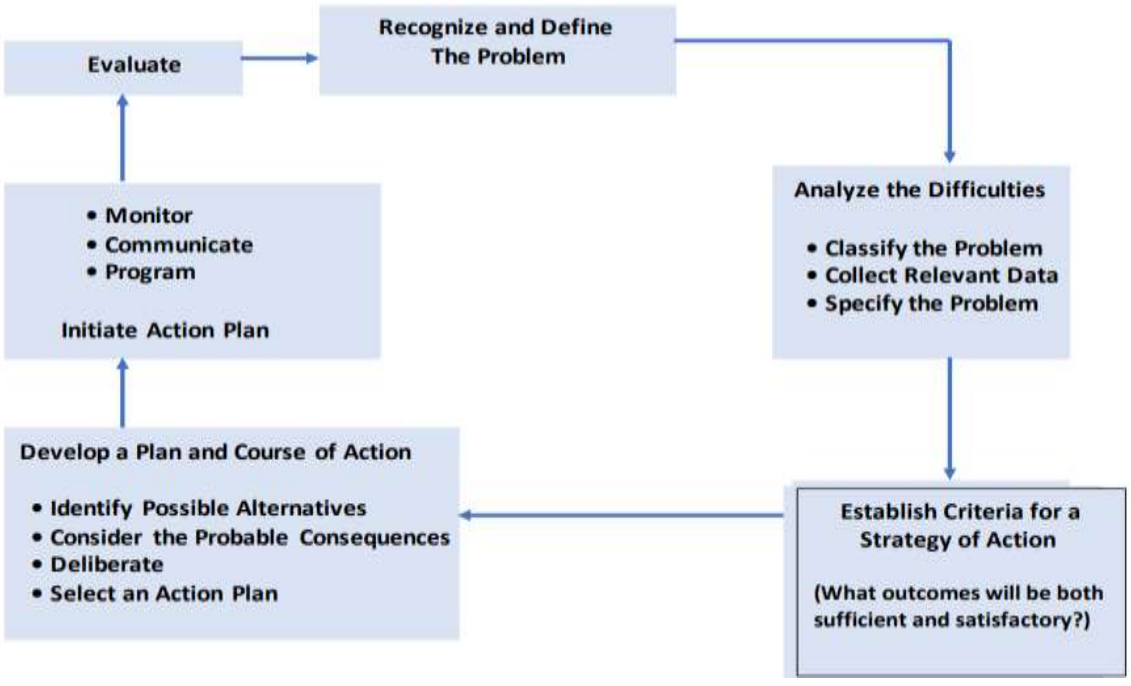
4. Develop a plan of action by identifying a set of alternatives, considering the likely consequences ofeach option. At this stage the decision maker exams all relevant options and their consequences,deliberates, and selects a multi-step plan of action with contingencies included in the plan.

5. Initiate the action plan

6. Evaluate the implemented plan in terms of the criteria you have established for a satisfactory solution.

There are some similarities between the classic model (optimizing) and the administration model (satisficing).

The major difference is that the administrative model calls for a decision that is satisfactory rather than theultimate best solution. This difference comes into play early in the decision-making cycle. After the problemhas been defined and analyzed, and before proceeding with the generation of alternatives, the decision makerconfronts the issue of the criteria for a satisfactory outcome. What is the minimum that is acceptable as anoutcome? What is satisfactory in this circumstance? What is sufficient? These questions are answered beforedeveloping a plan of action. If time is short, the process may be limited to a short list of alternatives, the so called truncated model of statisficing



Although the satisfying strategy that we have just described is well suited to dealing with many problems in educational administration, occasionally some situations require an incremental approach. When alternatives are difficult to discern or the consequences are so complicated as to elude prediction, satisfying may be unproductive. For example, to what new activities should a school administrator allocate more resources? The answer to this question is probably more adequately addressed by considering only alternatives that differ

marginally from existing conditions. The underlying assumption of this strategy is that small incrementalchanges will not produce major unanticipated negative consequences for the organization; hence, in complexand unpredictable situations, an incremental approach of muddling-through may be appropriate.

Charles Lindblom (1959, 1980) first introduced and formalized the incremental strategy. He characterizesthis method of deciding as the science of muddling through; he argues this may be the only feasibleapproach to systematic decision making when the issues are complex, uncertain, and riddled with conflict.

The process is formally described as a method of successive limited comparisons. The incrementalapproach of muddling does not require objectives, nor exhaustive analysis of alternatives and consequences,nor a priori determination of satisfactory outcomes. Instead only a small set of alternatives, unlikely todramatically alter the existing situation, is assessed by successively comparing theirconsequences until oneseems reasonable and safe; that is, a feasible course of action emerges as alternatives and consequences ofaction are explored. The marginal differences in value among alternative courses of action rather than any priorobjectives serve as the basis for deciding.

The incremental model also greatly reduces the number of alternatives considered. The strategy considersonly alternatives that are unlikely to cause disruption, analyzes only differences between the current state andproposed outcomes, and focuses on the decision maker's narrow range of interest. With this approach, thecomplexity of decision making is reduced and made manageable. Lindblom (1959) argues that simplificationof analysis, achieved by concentrating on alternatives that differ only slightly, is not capricious; limiting theemphasis to small variations from existing situations merely makes the most of available knowledge. Further,administrators who restrict themselves to a reasonable set of alternatives on the basis of their experiences canmake predictions of consequences with accuracy and confidence. This narrow focus on outcomes avoidspossible paralysis caused by attempts to predict and analyze all possible outcomes of a specific course ofaction.

The incremental model of muddling through is an alternative to theory. In both the classical and theadministrative models, theory is viewed as a useful way to bring relevant knowledge to bear on specificproblems. As problems become increasingly complex, however, the inadequacies of our theories to guidedecisions become more prevalent. Muddling through, as this a strategy of incremental comparisons is mostcommonly known, suggests that in complex situations, decision makers make more progress if theysuccessively compare concrete empirical options rather than emphasize more abstract, theoretical analyses.

Although muddling through may be a common approach used by administrators, it has its drawbacks. Asthe term suggests the strategy has little direction; thus, the process is likely to produce aimlessness,

organizational drift, and habit of "playing it safe." The strategy is also conservative and avoids significant changethat may be needed.

14.3 The Mixed-Scanning Model: An Adaptive Strategy

Most administrators make decisions with only partial information and under the press of time. AmitaiEtzioni .(1986, 1989) offers a model of decision making that is a pragmatic approach to complexity and uncertainty. His mixed-scanning model is a synthesis of satisfying and incremental strategies, the last two models discussed. Mixed scanning is driven by two questions:

1) What is the organization's mission and policy?

2) What decisions will move the organization toward its mission and policy?

Mixed scanning seeks to use partial information to make satisfactory decisions without gettingbogged down either by examining all the information or by proceeding blindly with little or no information.

Mixed scanning uses a strategy of adaptive satisfying, which is a mixture of shallow and deep examination of data that unites the comprehensiveness of the administrative model with the flexibility ofthe incremental model (Etzioni, 1986).

As we have suggested, there are times when alternatives are difficult to discern and whenconsequences are hard to predict. In these situations, administrators too often muddle through. Theincremental decisions are tentative—small steps taken in directions not far afield from the existing state.

These decisions are patently conservative and often without direction. Unless decision makers evaluatethese incremental decisions in terms of some broad, fundamental policy, organizational drift is likely.

The mixed-scanning model has its roots in medicine. It is typically the way effective physicians makedecisions. Unlike increment lists, medical doctors know what they are trying to achieve (healthyfunctioning of the patient). Moreover, unlike decision makers who seek to optimize, they neither engage all their resources on the basis of an initial diagnosis nor wait for every conceivable bit of personal history and scientific data before beginning treatment. Doctors survey the symptoms of a patient, analyze thedifficulty, initiate a tentative treatment, and, if it fails, try something else (Etzioni, 1989). The principles formixed scanning are straightforward; seven basic rules for a mixed-scanning strategy have beenadvanced by Etzioni (1989) and Hoy and Tarter (2003) as follows:

1. Use focused trial and error. Search for reasonable alternatives; then select and testthem; and adjust and modify the action as the outcomes become clear. Focused trialand error assumes that, despite the fact that important information is missing, theadministrator must act.

2. Be tentative; proceed with caution. Be ready to modify a course of action as necessary. It is important that administrators view each decision as experimental, expecting to revise it.

3. If uncertain, procrastinate. Waiting is not always bad, especially when the situation is ambiguous. Delay as long as possible so that more information can be collected and analyzed before acting.

4. Stagger your decisions. Commit to a decision in stages, evaluating the outcomes ofeach phase before proceeding to the next phase.

5. If uncertain, fractionalize decisions. Do not invest all your resources on a decision, but instead use partial resources until the consequences are satisfactory.

6. Hedge your bets. Implement several competing alternatives, provided that each has satisfactory outcomes. Adjust on the basis of the results.

7. Be prepared to reverse your decision. Try to keep decisions tentative. Reversibledecisions avoid overcommitment to a course of action with partial information.

Educational administrators can skillfully employ all of these adaptive satisfying techniques as theyemploy mixed scanning. All illustrate flexibility, caution, and a capacity to proceed with partial knowledge.

When time is limited or the decision is not that important, truncated adaptive satisfying may beappropriate, in which case, both the range and number of facts and choices are limited and the analysesare not as deep or penetrating. In sum, the mixed-scanning model has the following distinctive features:

• Broad, organizational policy gives direction to tentative incremental decisions.

• Good decisions have satisfactory outcomes that are consistent with policy and mission.

• The search for alternatives is limited to those close to the problem.

• Analysis recognizes that important information is missing but action is imperative.

• Theory, experience, and successive comparisons are used together.

14.4 A Contingency Model: Matching Strategy and Situation

The Classic Model (Optimizing), theAdministrative Model (Satisficing), the Incremental Model (Muddling Through) and the Mixed ScanningModel (Adaptive Satisfying). Which is the best way to decide? There is no one best way to decide justas there is no one best way to organize, to teach, or to do research. As in most complex tasks, acontingency approach is best—match the approach with the situation.

The Classic Model The decision strategies can be ordered according to their capacity to deal withcomplexity and conditions of increasing uncertainty and conflict (Grandori, 1984). When decisions aresimple, information complete and certain, and a collective preference (no conflict) exists, then anoptimizing strategy seems most appropriate, but as we have already noted, organizational problems arealmost never simple, certain, and without conflict in preferences; thus, optimizing is not really a choice.

14.5 The Administrative Model

When uncertainty and conflict prevail, as is typically the case in administrative decision making, a satisfying strategy becomes appropriate. The administrative model isflexible and heuristic. Decisions are based on comparisons among consequences of alternatives andthe decision maker's aspiration level. Only a partial exploration of the alternatives is performed and theaspiration level is lowered. Lack of time, of course, may truncate the process by forcing the considerationof fewer options.

14.6 The Incremental Model

When alternatives are difficult to discern or consequences are so complicated as to elude prediction, even a satisficing strategy has its limits. In such situations, anincremental strategy may seem appropriate because such an approach deals with both uncertainty andconflict of interest by assuming that small changes will not produce large negative consequences. Thus,when the organization is in turmoil and without direction, muddling through (incremental approach) maybe the appropriate short-run strategy

14.7 The Mixed Scanning Model

Some students of organization, however, argue that even when thedecisions are complex and outcomes are difficult to predict, instrumentalism is too conservative and selfdefeating. Small, incremental decisions made without guidelines are often counterproductive and lead to action without direction. Instead, mixed scanning (adaptive satisfying) is recommended to deal withexceedingly complex decisions. Mixed scanning combines the best of both the satisficing and theincremental models; a strategy of satisfying is combined with incremental decisions guided by broad policy. Full scanning is replaced by partial scanning of a set of satisfactory options, and tentative andreversible decisions are emphasized in an incremental process that calls for caution as well as a clearsense of destination. Time again may limit the number of possibilities considered before action. In brief,the appropriate decision strategy depends on a number of factors.

14.8 A Contingency Model

All of the previous models, with the possible exception of the classic model,have their utility, but it should be clear that none of these models is always appropriate. A simplifiedcontingency model for selecting the appropriate decision strategy based on three questions is proposed:

1. Information: Is there sufficient information to define a satisfactory outcome?

2. Time: Is there time to engage in a comprehensive search?

3. Importance: How important is the decision?

If there is sufficient information to define a satisfactory outcome, then satisfying is the model ofchoice. But depending on time and the importance of the decision, the satisfying strategy can be truncated and adapted. For example, if there is sufficient time to engage in a comprehensive search,but the decision is not that important, then truncated satisfying is the appropriate strategy. If, however,there is insufficient information, then adaptive satisfying is

the preferred strategy. But again, depending on time and importance of the decision, adaptive satisfying may be truncated or moderated by muddling through. For example, if there is insufficient information or limited time or the decision is not that important,then muddling through seems an appropriate decision strategy.

The three questions guide the decision maker along eight possible paths—each with an appropriatedecision strategy. Satisfying, adaptive satisfying, truncated versions of each, as well as muddlingthrough are appropriate depending on the situation. These situations are defined by information, time,and importance. As you can see from the decision tree in most decisions school administratorswill confront require a form of satisfying—full satisfying or adaptive satisfying and a truncated versionof either if the decision is not important. Muddling only rarely is called for in chaotic or complex situations,and then, only for temporary relief. In general, a simple guide to selecting the appropriate decisionstrategy is to evaluate and choose either a satisfying or adaptive satisfying strategy or some variation ofthese two.

Effective decision making is an integral part of modern workplace management. Managers, team leaders and even employees need to make rational and sound decisions every day. The right decisions, choices and approaches help in meeting organizational goals more efficiently. It helps organizations adopt and implement measures that optimize growth in terms of products and/or services offered. In other words, decisions drive actions.

14.9 Herbert Simon Model

Herbert Simon was one of the first theorists to highlight the importance of decisions in a business environment. Read on to see why the Herbert Simon Decision Making Theory still holdsrelevance in current times.

Before we explore the Decision Making Theory, let’s understand the context in which it emerged. Herbert A. Simon is an American economist and popular scientist who was known for his multiple contributions in the fields of psychology, statistics and mathematics, among others. He was awarded the Nobel Prize for Economics in 1978. He is best known for his work on corporate decision making, also called behaviorism.

The Herbert Simon Decision Making Theory first appeared in his renowned book, Administrative Behavior (1947). He suggested that decisions were critical because if they weren’t taken on time, it’ll negatively impact an organization’s objective. The concept can be divided into two parts—one is the decision that someone arrives at and another is the process or actions taken. In other words, implementing a decision is as important as making that decision.

14.9.1 Understanding The Decision Making Theory By Simon

The Simon Decision Making Theory is a framework that provides a more realistic view of the world, where decisions affect prices and outputs. The theorist argued that making a decision is making a choice between alternative courses of action. It can even mean choosing between action and non-action. In contrast to classical theorists, Simon suggests that there is never one best course of action or decision. It’s because one can’t have complete

information about something, therefore, there will always be a better course of action or decision.

The Decision Making Theory by Simon also considers psychological aspects that classical economists overlooked or ignored. Internal factors such as stress and motivations, among others, limit an individual's capacity to solve complex problems. In short, decisions are based on bounded rationality—humans behave differently when there are risks and uncertainty involved. At the core of the theory lies 'satisfying', which is a combination of satisfying and sufficing. It suggests that one should pursue objectives or make decisions that involve minimum risks and complications as opposed to focusing on maximizing profits.

There Are Three Stages Involved In The Decision Making Process:

14.9.1(a) Intelligence Activity Stage

At this stage, people identify the problems in an organization and the upper management analyzes the organizational environment to work toward a solution.

14.9.1(b) Design Activity Stage

In order to identify possible solutions to problems, the upper management looks for suitable strategies. They further analyze the merits and demerits to select a particular course of action.

14.9.1(c)Choice Activity Stage

After making a list of alternatives, the choice activity stage begins. It critically examines and evaluates the various consequences of all alternatives and the most suitable course of action is selected. This stage requires creativity, judgment and quantitative analysis skills.

14.9.1(d)Exploring The Types Of Decisions

With respect to organizational decision-making, the Simon Decision Making Theory recognized two types of decisions:

14.9.2 Programmed

Programmed decision making involves those decisions that already have a plan or rule in place, which is used to reach a solution or conclusion. They follow already established guidelines and formal patterns. For example, managers have already made such decisions before and it's a repetitive and routine process.

14.9.3 Non-Programmed

Contrary to programmed decision making, non-programmed decisions are ill-structured and one-time decisions. Problems or situations that don't have a concrete set of rules or guidelines to follow rely on non-programmed decision making. These are complex and have long-term impact.

Whether it's a programmed or non-programmed decision, here are effective strategies to make sound decisions at work.

Clearly Define The Problem You Need To Solve Through Your Decision

Always Do Your Homework And Collect Relevant Information Before Arriving At A Decision

Evaluate Whether The Information You Gathered Addresses The Original Purpose

Herbert Simon's Decision Making Theory also emphasized the importance of rationality. He proposed the concept of bounded rationality, where people make decisions within certain limitations. He further supported the behavioral aspect of organization theory as personal biases and perspectives affect the way employees make decisions.

14.10 Group Decision making

Types of group decision-making techniques are;

- Brainstorming.
- Nominal Group Technique.
- Electronic Meeting.
- Multi-Voting.
- Delphi Method.
- Dialectic Decision Methods.

14.10.1 Brainstorming

Brainstorming is a process for developing creative solutions to problems. This technique was developed by Alex Osborn a partner in an agency. It is a popular method for encouraging creative thinking in groups of about 8 people.

Alex Faickney Osborn, an advertising manager, popularized the method in 1953 in his book, Applied Imagination. Ten years later, he proposed that teams could double their creative output with brainstorming.

Simply brainstorming is meant to overcome pressures for conformity in the interacting group that retard the development of creative alternatives.

It is built around four basic guidelines for participants:

- Generate as many ideas as possible.
- Be creative, freewheeling, and imaginative.
- Build upon, extend, or combine earlier ideas.
- Withhold criticism of others' ideas.

It is a combination of group problem solving and discussions. It works on the belief that the more the number of ideas, the greater the possibility of having a solution to the problem that is acceptable to all. It starts with the group generating ideas which are then analyzed, with action points based on the discussions.

Brainstorming works by focusing on a problem, and then deliberately coming up with as many solutions as possible and by pushing the ideas as far as possible.

One of the reasons it is so effective is that the brainstormers come up with new ideas in a session and spark off from associations with other people's ideas by developing and refining them.

14.10.2 Nominal Group Technique

Another technique is the nominal group technique (NGT), which involves.The nominal group technique restricts discussion or interpersonal communication during the decision-making process, hence, the term nominal. Group members are all physically present, as in a traditional committee meeting, but members operate independently. Specifically, a problem is presented and then the following steps take place:

- Members meet as a group but, before any discussion takes place, each member independently writes down his or her ideas on the problem.
- After this silent period, each member presents one idea to the group. Each member takes his or her turn, presenting a single idea until all ideas have been presented and recorded. No discussion takes place until all the ideas have been recorded.
- The group now discusses the ideas for clarity and evaluates them.
- Each group member silently and independently rank-orders the ideas. The idea with the highest aggregate ranking determines the final decision.

The chief advantage of the nominal group technique is that it permits the group to meet formally but does not restrict independent thinking, as does the interacting group.

It's the method of tallying and coming to a resultant conclusion that sets the nominal group technique apart from other methods.

The initial stage of the technique gives each individual a chance to state his opinion on the solution. He's also allowed to elaborate slightly with a brief accompanying explanation about why he chose the way he did.

Duplicate solutions are then eliminated from the pool, leaving only original solutions behind. The individuals then rank the remaining solutions according to numerical preference, and all of these preferences are tallied and considered to render the most accurate results.

14.10.3 Electronic Meeting

The most recent approach to group decision making blends the nominal group technique with sophisticated computer technology.

It's called the computer-assisted group or electronic meeting. It is a meeting in which members interact by a computer, allowing for anonymity of comments and aggregating votes.

Once the technology is in place, the concept is simple. Issues are presented to the participants, and they typed their responses into their computer screen. Individual comments, as well as aggregated votes, are displayed on a projection screen.

The major advantages of electronic meetings are mystery, honesty, and speed.

Participants can anonymously type any message they want, and it flashes on the screen for all to see at the push of a participant's board key. It also allows people to be brutally honest without penalty. And it's fast because chitchat is eliminated, discussions don't digress, and many participants can "talk" at once without stepping on another's toes.

The future of group meetings undoubtedly will include extensive use of this technology.

Team decision making is a time-consuming process, and before the team leader organizes the participation of the full team, he/she must be sure that he/she has enough time and resources for the decision-making process and choose a technique that is most appropriate in a given situation, keeping the profile of team members in mind.

14.10.4 Multi-Voting

It starts with a number of rounds of voting where an individual casts his/her vote for the shortlisted options. Each individual can cast one vote at a time.

In this way, the options favoring the maximum number of votes are carried to the next round.

This process is repeated until a clear winning option is obtained.

14.10.5 Delphi Method

In this method of decision making, the facilitator allows team members to brainstorm their ideas and submit their ideas "anonymously individually." The other team members do not know the owner of the pictures.

The facilitator then collects all the inputs and circulates them among others for modifying or improving them. This process continues until a final decision is made.

The Delphi technique was originally developed by Rand Corporation to systematically gather the judgments of experts for use in developing forecasts.

It is designed for a group that does not meet face-to-face. The Delphi method is a structured communication technique or method, originally developed as a systematic, interactive forecasting method that relies on a panel of experts.

The experts answer questionnaires in two or more rounds. After recruiting participants, the manager develops a questionnaire for them to complete.

The questionnaire is relatively simple which contains straightforward questions that deal with the issue, trends in the area, new technological developments, and other factors the manager is interested in.

The managers summarize the responses and reports back to the experts with another questionnaire.

This cycle may be repeated as many times as necessary to generate the information the managers need. It is useful when experts are physically dispersed, anonymity is desired, or

the participants are known to have trouble communicating with one another because of extreme differences of opinion.

This method also avoids the intimidation problems that may exist in decision-making groups.

On the other hand, the technique eliminates the often fruitful results of direct interaction among group members."

14.10.6 Dialectic Decision Methods

Some face-to-face decision taking groups converge too quickly on one alternative while overlooking others. Their incomplete evaluation of options may reflect either the participants' dislike of meetings or their lack of willingness to raise and confront tough issues.

The dialectic decision method (DDM), which traces its roots to Plato and Aristotle, offers a way of overcoming these problems.

The dialectic process begins with a clear statement of a problem to be solved. Then two or more competing proposals are generated. A key step follows in which participants identify the explicit or implicit assumptions that underlie each submission.

The group then breaks into advocacy subgroups, which examine and argue the relative merits of their positions.

Then the entire group makes a decision based on the competing presentations. This decision may mean embracing one of the alternatives, forging a compromise from several ideas, or generating a new proposal.

The merits of DDM include a better understanding of the proposals, their underlying premises, and their pros and cons by the participants. Members are also likely to feel more confident about the choice they make.

Disadvantages include the propensity to forge a compromise to avoid choosing sides and the tendency to focus more on who were the better debaters than what the best decision should be. Nevertheless, the dialectic method holds promise for future decisionmaking groups.

14.11 Summary

The Herbert Simon Decision Making Theory opened new doors for an organization. By shifting focus to the human mind, he helped administrations identify and resolve many unaddressed issues.

Effective decision making is a much-needed fundamental skill in your personal and professional life. Harappa's Making Decisions course will equip you with frameworks to process, reflect and include multiple perspectives for informed decision making. Enrolling with Harappa is good decision making

14.12Key words

Non-Programmed-Contrary to programmed decision making, non-programmed decisions are ill-structured and one-time decisions. Problems or situations that don't have a concrete set of rules or guidelines to follow rely on non-programmed decision making.

Programmed Decision Making-Programmed decision making involves those decisions that already have a plan or rule in place, which is used to reach a solution or conclusion

Simon Decision Making Theory- The Simon Decision Making Theory is a framework that provides a more realistic view of the world, where decisions affect prices and outputs

A Contingency Model- All of the previous models, with the possible exception of the classic model, have their utility, but it should be clear that none of these models is always appropriate

The Mixed Scanning Model-Some students of organization, however, argue that even when the decisions are complex and outcomes are difficult to predict, instrumentalism is too conservative and self defeating

The Incremental Model-When alternatives are difficult to discern or consequences are so complicated as to elude prediction, even a satisfying strategy has its limits

The Administrative Model-When uncertainty and conflict prevail, as is typically the case in administrative decision making, a satisfying strategy becomes appropriate.

14.13self Assessment Questions

1. Briefly Discuss the various models of Decision Making
2. Explain Classical Model of Decision Making
3. Discuss the Types of Decision
4. Elaborate the Herbert Simon Models
5. Discuss the Group Decision Making Models

14.14Suggested Readings

1. Laudon, Kenneth, C. and Laudon, Jane Price :Manangment Information systems – A contemporary Perspective, Macmillan , New York .
2. Jerome, Kanter, : Management Information Systems, Prentice Hall of India, New Delhi
3. Murdick and Ross R. Claggetti, : Information system for Modern Management, Printiee Hall of India, New Delhi .
4. Sonn, James, A, : Information system Management, Wordsworth Pub. Co., USA , 1982.

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LESSON -15

DECISION SUPPORT SYSTEM

Learning objectives

- ✓ To know the Purpose of Decision Support system
- ✓ To Understand the Components of Decision Support system
- ✓ To learn the Types of Decision support system
- ✓ To Discuss the Fundamental components of DSS
- ✓ To study the Context and Conditions of Decision Making
- ✓ To Identify the Decision-Making at Different Levels in the Organisation

Structure

15.0 Introduction

A decision support system (DSS) is an information system that aids a business in decision-making activities that require judgment, determination, and a sequence of actions. The information system assists the mid- and high-level management of an organization by analyzing huge volumes of unstructured data and accumulating information that can help to solve problems and help in decision-making. A DSS is either human-powered, automated, or a combination of both.

15.1 Purpose of a Decision Support System

A decision support system produces detailed information reports by gathering and analyzing data.

Hence, a DSS is different from a normal operations application, whose goal is to collect data and not analyze it.

In an organization, a DSS is used by the planning departments – such as the operations department – which collects data and creates a report that can be used by managers for decision-making. Mainly, a DSS is used in sales projection, for inventory and operations-related data, and to present information to customers in an easy-to-understand manner.

Theoretically, a DSS can be employed in various knowledge domains from an organization to forest management and the medical field. One of the main applications of a DSS in an organization is real-time reporting. It can be very helpful for organizations that take part in just-in-time (JIT) inventory management.

In a JIT inventory system, the organization requires real-time data of their inventory levels to place orders “just in time” to prevent delays in production and cause a negative domino effect. Therefore, a DSS is more tailored to the individual or organization making the decision than a traditional system.

15.2 Components of a Decision Support System

The three main components of a DSS framework are:

15.2.1. Model Management System

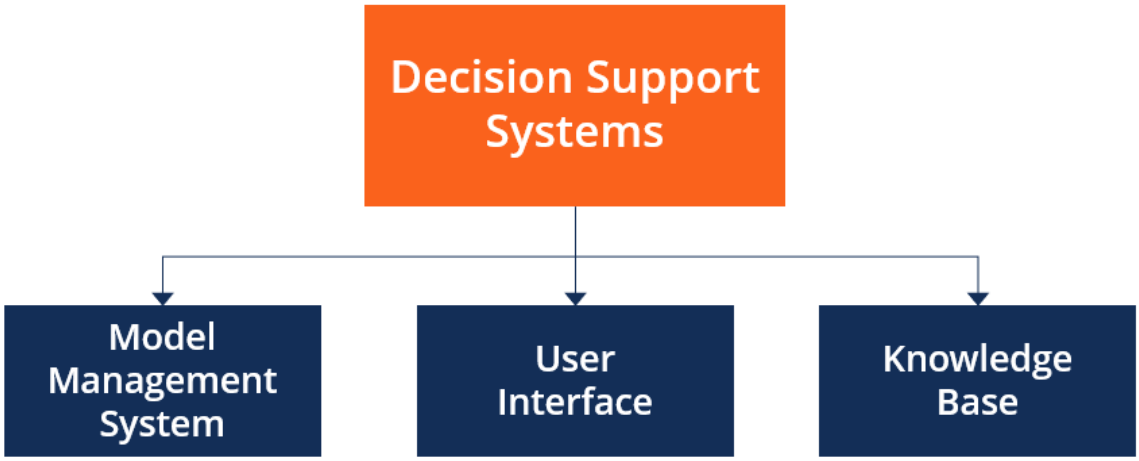
The model management system S=stores models that managers can use in their decision-making. The models are used in decision-making regarding the financial health of the organization and forecasting demand for a good or service.

15.2.2. User Interface

The user interface includes tools that help the end-user of a DSS to navigate through the system.

15.2.3. Knowledge Base

The knowledge base includes information from internal sources (information collected in a transaction process system) and external sources (newspapers and online databases).



15.3 Types of Decision Support Systems

Communication-driven: Allows companies to support tasks that require more than one person to work on the task. It includes integrated tools such as Microsoft SharePoint Workspace and Google Docs.

Model-driven: Allows access to and the management of financial, organizational, and statistical models. Data is collected, and parameters are determined using the information provided by users. The information is created into a decision-making model to analyze situations. An example of a model-driven DSS is Dicodess – an open-source model-driven DSS.

Knowledge-driven: Provides factual and specialized solutions to situations using stored facts, procedures, rules, or interactive decision-making structures like flowcharts.

Document-driven: Manages unstructured information in different electronic formats.

Data-driven: Helps companies to store and analyze internal and external data.

Advantages of a Decision Support System

1. A decision support system increases the speed and efficiency of decision-making activities. It is possible, as a DSS can collect and analyze real-time data.
2. It promotes training within the organization, as specific skills must be developed to implement and run a DSS within an organization.
3. It automates monotonous managerial processes, which means more of the manager's time can be spent on decision-making.
4. It improves interpersonal communication within the organization.

Disadvantages of a Decision Support System

1. The cost to develop and implement a DSS is a huge capital investment, which makes it less accessible to smaller organizations.
2. A company can develop a dependence on a DSS, as it is integrated into daily decision-making processes to improve efficiency and speed. However, managers tend

to rely on the system too much, which takes away the subjectivity aspect of decision-making.

3. A DSS may lead to information overload because an information system tends to consider all aspects of a problem. It creates a dilemma for end-users, as they are left with multiple choices.
4. Implementation of a DSS can cause fear and backlash from lower-level employees. Many of them are not comfortable with new technology and are afraid of losing their jobs to technology.

15.4 Capabilities Decision Support Systems

Decision support systems are interactive, computer-based systems that aid users in judgment and choice activities. They provide data storage and retrieval but enhance the traditional information access and retrieval functions with support for model building and model-based reasoning. Theysupport framing, modeling, and problem solving.

Typical application areas of DSSs are management and planning in business, health care, the military, and any area in which management will encounter complex decision situations. Decision support systems are typically used for strategic and tactical decisions faced by upper-level management—decisions with a reasonably low frequency and high potential consequences—in which the time taken for thinking through and modeling the problem pays off generously in the long run.

15.5 Fundamental Components of DSS

15.5.1 Database management system (DBMS)

A DBMS serves as a data bank for the DSS. It stores large quantities of data that are relevant to the class of problems for which the DSS has been designed and provides logical data structures (as opposed to the physical data structures)with which the users interact. A DBMS separates the users from the physical aspects of thedatabase structure and processing. It should also be capable of informing the user of the typesof data that are available and how to gain access to them.

15.5.2 Model-base management system (MBMS)

The role of MBMS is analogous to that of a DBMS.Its primary function is providing independence between specific models that are used in a DSSfrom the applications that use them. The purpose of an MBMS is to transform data from theDBMS into information that is useful in decision making. Since many problems that the userof a DSS will cope with may be unstructured, the MBMS should also be capable of assisting the user in model building.

15.5.3 Dialog generation and management system (DGMS)

The main product of an interaction witha DSS is insight. As their users are often managers who are not computer-trained, DSSsneed to be equipped with intuitive and easy-to-use interfaces. These interfaces aid in modelbuilding, but also in interaction with the model, such as gaining insight and recommendations from it. The primary responsibility of a DGMS is to enhance the ability of the system user to utilize and benefit from the DSS. In the remainder of this article, we will use the broader term user interface rather than DGM

Decision making can be defined as making a choice among alternative courses of action or as the process of choosing one alternative from among a set of rational alternatives. This definition has three different but interrelated implications..

15.6 Decision-Making

Effective decision-making requires a clear understanding of the situation. Most people think that an effective decision is one that optimism some factor such as profits, sales employee welfare, or market share. In some situations, however, the effective decision may be one that minimizes loss, expenses, or employee turnover. It may even mean selecting the best method for going out of business or terminating a contract.

1. When managers make decisions they exercise choice — they decide what to do on the basis of some conscious and deliberate logic or judgement they have made in the past.

2. When making a decision managers are faced with alternatives. As Stoner puts it: "It does not take a wise manager to reach a decision when there are no other possible choices. It does require wisdom and experience to evaluate several alternatives and select the best one."

3. When making a decision managers have a purpose. As R. W. Morell has put it, there is hardly any reason for carefully making a choice among alternatives unless the decision has to bring them closer to same goal.

Therefore in this article the stress will be on the formal decision-making process, i.e., how managers proceed systematically to reach logical decisions that can help them in the best possible way to reach their goals.

The implication is simple enough: Managers are almost always faced with a problem or oppor-tunity. So they propose and analyse alternative courses of action and finally make a choice that is likely to move the organisation in the direction of its goals.

We noted that effective decision requires an under-standing of the situation. In a like manner, the effectiveness of any decision has to be assessed in terms of the decision--maker's underlying goal.

15.7 The Context of Decision-Making

Here, we treat decision-making as essentially an individ-ual process, but a process that occurs in an organisa-tional context. The individual decision-maker lies at the centre of the proc-ess, but any given decision is likely to be influenced by a number of other people, departments and organisations. It shows such important influences as super-visors, peers and colleagues, subordinates, other organisational components (such as other departments and their managers), and the environment (including elements of the task environment, such as competitors and suppliers, as well as general environmental factors such as technology and the economy).

15.8 Conditions for Decision-Making

Although decision-making is essentially an individual process, the surrounding conditions can vary widely. Organizational decisions are made under three con-ditions, viz., certainly, risk and uncertainty.

15.8.1 Decision Making Under Certainty

When managers know with certainty what their possible alternatives are and what conditions are associated with each alternative, a state of certainty exists.

15.8.2 Decision Making under Risk

A more realistic decision-making situ-ation is a state of risk. Under a state of risk, the availability of each alternative and its potential pay-offs (rewards) and costs are all associated with profitability estimates. It is, therefore, quite obvious that the key element in decision-mak-ing under a state of risk is accurately determining the probabilities associated with each alternative.

15.8.3 Decision Making under Uncertainty

However, most important and strategic decisions in modern organisations are taken under conditions of uncertainty. A state of uncertainty refers to a situation in which the decision maker does not know what all the alternatives are, and the risks associated with each, or what consequences each is likely to have.

This complexity arises from the complexity and dynamism of today's organisations and their environments. All successful organi-sations have made various effective decisions under uncertainty. The key to effective decision-mak-ing under uncertainty is to acquire as much relevant information as possible and to approach the situation from a logical and rational perspective. Intuition, judgement and experience always play a very important role in decision-making under uncertain conditions.

15.9 Types of Decisions

As managers "we will make different types of decisions under different circumstances. When deciding whether or not to add a new wing to the administration building, or where to build a new plant, we will have to consider our choice carefully and extensively. When deciding what salary to pay a new employee, we will usually be able to be less cautious. Similarly, the amount of information we will have available to us when making a decision will vary. When choosing a supplier, we will usually dose on the basis of price and past performance. We will be reasonably confident that the supplier chosen will meet our expectations. When deciding to enter a new market, we will be much less certain about the success of our decision. For this reason, we will have to be particularly careful making decisions when we have little past experience or information to guide us."

In short, the nature and circumstances of a decision can vary enormously. Managers have to vary their approach to decision-making, depending on the particular situation involved. For our purposes, it will be useful to distinguish between situations that call for programmed decisions and those that call for non-programmed decisions. Business managers have to make various types of decisions. Such decisions can be placed into three broad categories: technical decisions, managerial decisions and institutional decisions.

These three types of decisions may now be briefly illustrated:

15.9.1 Technical Decisions:

In every organisation there is need to make decisions about core activities. These are basic activities relating directly to the 'work of the organisation'. The core activities of Oil India Ltd. would be exploration, drilling, refining and distribution. Decisions concerning such activities are basically technical in nature. In general, the infor-mation required to solve problems related to these activities is generally concerned with the operational aspects of the technology involved.

In short, technical decisions are concerned with the process through which inputs such as

people, information or products are converted into outputs by the organisation.

15.9.2 Managerial Decisions:

Such decisions are related to the co-ordination and support of the core activities of the organisation.Managerial decision-making is also concerned with regulating and altering the relationship between the organisation and its external (immediate) environment. In order to maximize the efficiency of its core activities it becomes absolutely essential for management to ensure that these actions are not unduly disturbed by short-term changes in the environment.

This explains why various organisations often build up inventories and forecasting of short-term changes in demand and supply conditions are integral parts of managerial decision-making.

15.9.3 Institutional Decisions

Institutional decisions concern such diverse issues as diversification of activities, large-scale capital expansion, acquisition and mergers, shifts in R & D activities and various other organisational choices. Such decisions obviously involve long-term planning and policy formulation.

In the words of Boone and Koontz: "Institutional decisions involve long-term planning and policy formulation with the aim of assuring the organisa-tion's survival as a productive part of the economy and society." The implication is clear: if an organisation is to thrive in the long run as a viable organisation, it must occupy a useful, productive place in the economy and society as a whole.

With changes in society and in its economic framework, an organisation must adapt itself to such changes. Otherwise it may cease to exist. Due to shortage of traditional sources of energy the passenger car industry of the U.S. was reeling under recession from 1973 onwards. Some automobile companies faced with falling demand for petrol-operated cars have produced battery-operated motor cars.

Managers in every organisation are faced with these three types of decisions, viz., technical, managerial and institutional. Table 8.1 illustrates each type of decision for two different organisa-tions: one profit-seeking firm (an oil company) and non-profit seeking firm (an oil company) and one non-profit organisation (a hospital).

15.10 Decision-Making at Different Levels in the Organisation:

A study of the decision-making in different organisations reveals that the three types of decisions listed above are not evenly spread throughout the organisation. In general most institutional decisions are mostly made at the supervisory level. This point is il-lustrated in Fig.8.4.

15.11 Types of Decisions and the Management Hierarchy

It gives an indication of the relative number of each type of decision made at each level in the organisations. However, the categories should not be treated as exclusive. For example, the production manager of a machinery manufacturing firm like the Texmaco might primarily be en-gaged in technical decisions, while the legal adviser of the company might be involved in institu-tional matters.

15.11.1 Programmed and Non-Programmed Decisions

Nobel Laureate H. A. Simon has distinguished between two types of decisions, viz., programmed and non-programmed moved decisions. He has made the point that decisions differ not only in their content but also in terms of their relative uniqueness. By the term 'relative uniqueness' he means the degree to which a problem or decision (1) has been seen before; (2) occurs frequently and at regular intervals; and (3) has been solved or resolved in a satisfactory manner.

According to Simon, programmed decisions are those which involve simple, common, frequently occurring problems that have well-established and understood solutions. On the contrary, non- programmed decisions are those involving new, often unusual or novel problems.

In the words of Stoner:
"Programmed decisions are those that are made in accordance with some habit, rule or procedure. Every organisation has written or unwritten policies that simplify decision--making in a particular situation by limiting or excluding alternatives."

A few examples of such decisions may now be given. In most situations managers will not have to worry about what to pay a new employee because most organisations have an established salary structure (or pay policy) for any position. (Of course, salary of highly skilled or top management is often negotiable. But these are exceptions rather than the rule).

In a like manner managers will not generally have to think about the routine problems they face every day. Their habits, or those of their peers, will help them decide quickly what to do about them.

There is no denying the fact that programmed decisions limit the freedom of managers to a considerable extent. In other words, managers hardly enjoy any discretion in matters involving programmed decisions set managers, decide what to do. This implies that programmed decisions set managers free on most occasions.

The policies, rules or procedures by which managers make decisions free them of the need to find out new solutions to every problem they face. For instance, it would really be time-consuming to decide how to handle customer complaints on an individual basis. Adoption of routine procedures such as permitting customers to exchange unsuitable merchandise would really help matters.

Since managers regularly have a series of decisions to make, organisations have to develop varying decision rules, programmes, policies, and procedures to use. Existing pay scales are used as guideline to fix the starting salary of a new factory guard or a new security officer. Similarly, when inventory of raw materials occurs.

What can be said in favour of programmed decisions is that such decisions can be made "quickly, consistently and inexpensively since the procedures, rules and regulations eliminate the time-consuming process of identifying and evaluating alternatives and making a new choice each time a decision is required. While programmed decisions limit the flexibility of managers, they take little time and free the decision maker to devote his or her efforts to unique, non-programmed decisions. It is perhaps easiest for managers to make programmed decisions."

It is perhaps easiest for managers to refer to a policy rather than think of some problem and suggest solution. Effective managers usually rely on policy as a time saver. But they must remain alert for any exceptional case(s). For example, in case of a multi-product firm like the Godrej, the company policy may put a ceiling on the advertising budget for each product.

However, a particular product, say Cinthol, may demand an expensive advertising campaign to counter a competitor's aggressive marketing strategy. In such a situation a programmed decision — that is a decision to advertise the product in accordance with budget guidelines — may prove to be wrong. Thus when a situation calls for a programmed decision managers must ultimately make use of their own judgement.

Non-programmed decisions, as Stoner has put it, are "those that are out of the ordinary or unique. If a problem is complex or exceptional, or, if it has not come up often enough to be covered by a policy, it must be handled by a non-programmed decision."

Such decisions are needed to solve problems like how to allocate an organisation's resources, what to do about a failing product line, how community relations should be improved, and almost all significant problems a manager faces. In Table 8.2, we prepare a list of the traditional and modern techniques of decision-making.

15.12 Techniques of Decision-Making

In those organisations and decision situations where non-programmed decisions are the rule, the creation of alternatives and the selection and implementation of the most appropriate one becomes the distinction between effective and ineffective managers is drawn on the basis of their ability to make good non- programmed decisions.

However, managers are often evaluated on the basis of their ability to solve problems, to apply creativity and judgement to the solution of problems and to make decisions in a logical, step-by-step manner. Since established procedures are of little use for making such decisions, new solutions are to be found out.

This explains why most management training programmes are directed towards improving a manager's ability to make non-programmed decisions by teaching them how to take such decisions.

How Good should the Decisions Be?

In traditional economic theory it is argued that the objective of the business manager is to maximize something. This is, of course, a realistic assumption provided the decision maker is able to obtain complete information concerning all possible alternatives and thus choose the best solution designed to achieve a particular goal. The manager will choose to maximize profit or some other value.

However, 1978 Nobel Laureate H. A. Simon has made extensive study of managerial behaviour and on the basis of his investigation arrived at the conclusion that modern managers do not always attempt to maximize profits. Since managers are often forced to make decisions in the absence of complete information there is departure from the goal of profit maximization. Managers rarely consider all possible alternatives to the solution of a problem. Rather they examine a few alternatives that appear to be likely solutions.

Most non-programmed decisions involve innumerable variables and it is neither possible nor feasible, with limited knowledge and resources, to examine them all. Therefore, Simon argues that instead of attempting to maximise, the modern manager satisfies.

The manager, in fact, examines four to five alternative possibilities and chooses the best possible option from among them, rather than investing the time necessary to examine thoroughly all possible alternatives.

H. A. Simon makes the following assumptions about the decision-making process:

1. Decision makers have incomplete information regarding the decision situation.

2. Decision makers have incomplete information regarding all possible alternatives.

3. Decision makers are unable or unwilling, or both, to fully anticipate the consequences of each available alternative.

One important concept that Simon derived from these ideas is the notion of bounded rationality. He specifically notes that decision makers are limited by their values and unconscious reflexes, skills and habits. They are also limited by less-than-complete information and knowledge.

Further, he argues that "the individual can be rational in terms of the organisation's goals only to the extent that he is able to pursue a particular course of action, he has a correct conception of the goal of the action, and he is correctly informed about the conditions surrounding his choice. Within the boundaries laid down by these factors his choices are rational-goal-oriented."

Essentially, Simon suggests that people may try to be rational decision makers but that their rationality has limits.

Consider the case of a manager attempting to decide where to locate a new manufacturing facility. To be rational, he or she must have the power and ability to make the correct decision, must clearly understand what the new facility is to do, and must have complete information about all alternatives. It is very unlikely that all of these conditions will be met, so the decision maker's rationality is bounded by situational factors.

According to Simon modern managers act within bounded rationality. The central feature of the principle of bounded rationality is Simon's contention that the so-called 'administrative man' does not follow an exhaustive process of evaluation of the options open to find a course of action that is satisfactory or good enough. This Simon calls 'satisfying' and he describes it in contrast to the actions of 'economic man', who selects the best possible option from among those that are available.

Simon states in Administrative Behaviour that managers 'satisfies', that is, look for a course of action that is satisfactory or good enough. The inference is that rather than optimizing in the strict sense of proceeding to a maximum they consider all the constraints bearing on the decision situation and choose a course of action that is satisfactory to them (i.e., good enough under the present circumstances).

In short, the concept of bounded rationality refers to "boundaries or limits that exist in any problem situation that necessarily restrict the manager's picture of the world. Such boundaries include limits to any manager's knowledge of all alternatives as well as such elements as prices, costs and technology that cannot be changed by the decision maker."

Consequently the manager hardly strives to reach the optimum solution but realistically attempts to reach a satisfactory solution to the problem at hand.

In fact, Simon's view of the modern manager is different from the views of other writers on management. He attempts to present a realistic picture of a decision maker who is faced with two sets of constraints — internal and external. The former include such things as the individual's intellectual ability (or-inability), training and experience, personality, attitudes and motivation.

The latter refer to all external influences — influences exerted by workers of the organisation and groups outside it. Simon does not attempt to prove that managers do not attempt to make effective decisions. He only recognizes the very important fact that more often than not, decisions are balanced with the cost (measured in terms of time and money) of making it.

15.13 Steps in Decision Making:

There are various types of decisions such as setting up a new area or adding or dropping a new product on the product line, or hiring additional sales persons to increase the market share for a particular product, or even dismissing a worker. Whatever may be type of decision the decision maker has to proceed through a number of well-defined and interrelated steps. Some decisions can be made in a minute's time.

On the contrary, others may take months or years. Some decisions may be made hur-riedly and thus prove to be ineffective. On the con-trary, some decisions may be taken after much deliberation and careful consideration of alternatives. But all decisions have to proceed through these steps. It illustrates the steps in the decision-making process. However, the actual process of decision-making may not be as rational as Fig. 8.5 implies.

1. Recognising and Defining the Decision Situation,

2. Perception of the Environment,

3. Establishing Objectives,

4. Problem Formulation,

5. Identification of Resources and Constraints,

6. Development of Alternatives,

7. Evaluation of Alternatives and Selection of a Course of Action,

8. Implementation,

9. Feedback, and

10. Follow-up and Evaluation.

Steps in Decision-Making

15.13.1. Recognising and Defining the Decision Situation

The first step in making a decision is recognising that a decision is necessary — there must be some stimulus to initiate the process. For example, when an impor-tant equipment breaks down, the manager has to de-cide whether to repair or replace it.

Moreover, the manager must also be able to define the situation. This is partly a matter of determining how the problem that is being addressed came about. This is an important step because situation definition plays a major role in subsequent steps.

15.13.2. Perception of the Environment

The manager does not operate in a certain environ-ment. Assessing the effect of possible future changes in the environment is an essential step in decision--making. The term 'environment' here covers all fac-tors external to the firm. This explains why the decision maker must become aware of and be sensi-tive to the decision environment before any decision is possible.

This sensitivity results from two inputs:

1. Specific information which is of relevance to the decision maker (such as cost control re-ports, quality control reports, periodical sales reports, data on raw materials prices, etc.).

2. General information which are impressionistic in nature about conditions and operations (such as the manager's 'feel' for the situation).

It is necessary to distinguish, at the outset, between the environment as an objective entity and the manager's perception of the environment. Most often than not decision makers filter the information they receive, i.e., they pay more attention to some information than to other information. This practice sometimes prove to be disastrous to both the decision maker and the organisation.

The manager's primary task is to monitor the environment for potential change. In fact, in every management information system there is an in-built early warning signal system of reporting various environmental developments such as new or adapted products by competing producers; changes in attitudes and sentiments of buyers; development of new processes or methods of production.

If the organisation is to survive and grow in the long nm it must be ready to adapt and evolve in response to diverse environmental changes. In short, while strategy should not be conceived as exclusively concerned with the relation between the enterprise and its environment, assessing the effects of possible future changes in the environment is an essential task in strategy formulation.

There are two steps to this process: the first is to consider how the relevant environmental factors may change; the second is to assess the strategic implications of such changes for the firm.

15.13.3. Establishing Objectives

When a manager makes a decision, he (she) chooses from some set of alternatives as the one he (she) believes will best contribute to some particular end result. That is, decisions are made within the context of, and influenced by, the objective or set of objectives defined by the decision maker. Thus the second step in the decision process is to establish objectives or to take account of those that have been previously defined.

Objectives have to be defined in a concrete, operational form, since if these are stated in a general or vague form, it becomes virtually impossible to establish whether or not a particular decision brings one closer to the stated goal.

Consider, for example, the following two ways in which a firm might state one of its objectives:

Objective A:

To increase our share of the market.

Objective B:

To increase our market share by at least 3.5% in the next fiscal year.

With 'Objective A', the firm has little way to evaluate the effectiveness of various decisions as they relate to their goal. A 0.001% increase in market share satisfies the objective, as does a 1% increase, or 10% increase. However, with an objective stated as in B, there would be less room for debate about success or failure.

The firm either increases market share by the prescribed amount in B might be revised. If the firm consistently achieves a given objective, then the objective might be reviewed or changed to prevent under-achievement.

15.13.4. Problem Formulation

With objectives firmly in hand, the next phase in the decision process is to define the particular problem that gives (give) rise to the need to make a decision. The fact that someone must make a decision implies that there is a problem to be solved. In defining or formulating a problem the decision maker should be as precise as possible and should state the problem explicitly. Problems act as barriers to the achievement of organisation goals.

In other words, they act as obstacles to be overcome by the decision makers — when an organization fails to achieve its goals, a performance gap is said to exist. This gap reveals the difference between the predicted or expected level of performance and the actual level.

Problem formulation seems to be the most neglected aspect of the decision-making process. More often than not it is simply assessed that the nature of a managerial problem is obvious to all concerned. A major problem, however, is that managers often feel psychologically uncomfortable to think about problems.

Moreover, since time management is a very real part of managerial work manages devote much of their time for problem solving and not for problem formulation. In general managers

simply do not give themselves sufficient time to consider the situation and do an effective job of problem formulation.

15.13.5. Identification of Resources and Constraints:

Just as a business manager does not operate in isolation, problem solving does not occur in vacuum. In fact, problem solving lies embedded in the fabric of the organisations and its external environ-ment. The truth is that most organisations face a multiplicity of problems at the same time. These problems compete for the lim-ited amount of organisation's resources and manager's attention.

Anything that contributes to problem solving is a resource which includes time, money, personnel, experience, equipment, raw materials and information. Managers use various types of resources and we often speak of five Ms in this context, viz., mate-rials, money, manpower, machinery and management. See Fig.8.7.

Basic Resources of the Organisation

However, managers are faced with vari-ous constraints in the decision-making process. A significant constraint is, of course, lack of adequate resources. Other constraints may be unfavourable government policy (such as the MRTP Act which acts as a constraint on the expansion of the so-called large houses in India), or adverse attitude of employees (due to lack of motivation and morale). In general constraints are factors that impede problem solution or limit managers in their efforts to solve a problem.

The decision maker has to develop a brief explicit list of the major resources which enables the decision maker to make the best possible utilization of the organisation's resources. In other words, such an exhaustive list permits the decision-maker to budget organisational assets in order to maximize their usefulness.

In a like manner the listing of constraints "alerts the decision maker to the important stumbling blocks affecting a solution so that they can be avoided." Furthermore, "organisations sometimes confront situations in which the absence of a specific resource or the existence of a particular constraint is a significant problem itself."

15.13.6. Development of Alternatives:

The generation of various possible alternatives is essential to the process of decision-making. Perhaps the most important step in decision-making process is to develop alternative courses of action to deal with the problem situation. It is generally useful to design the process in such a way that both obvious, standard solutions and creative, informative solutions or alternatives are generated.

In general, the more important the decision, the more attention is directed to developing alternatives. If the decision involves where to build a multi-crore rupee office building, a great deal of time and expertise will be devoted to identifying the best locations.

Although managers should encourage creative solutions, they should also recognise that various constraints often limit their alternatives. Common constraints include legal restrictions, moral and ethical norms, authority constraints, or constraints imposed by the power and authority of the manager, available technology, economic considerations and unofficial social norms.

In most real-life situations managers adopt a shortcut approach and thus fail to arrive at the best solution. In fact, managers often identify one or two alternatives very fairly and choose from among them. So more effective alternatives are not considered. Writers on organisations have suggested that creativity is needed at this stage in developing various possible alternatives for consideration.

How much time and money should be developing alternatives:

Time and money are the important resources at the disposal of the decision-maker. However, time seems to be the ultimate scarce resource of the manager. Moreover, since there are always additional alternatives waiting to be discovered, the process of generating alternatives could conceivably go on forever.

Managers should consider three proximate factors in determining the appropriate amount to spend in generating alternatives. Firstly, managers should assess how important is this problem or opportunity. The more important the decision the greater the value of marginal improvements in the solution.

The second factor is the ability of the decision-maker to differentiate accurately among alterna-tives determining the amount of time that he should devote in developing alternatives and cannot, in advance, tell the difference between two alternatives and cannot rank them accurately according to this likely effectiveness.

Thirdly, the larger the number of people concerned with a problem, the greater the number of likely alternatives to be sought.

In this context Boone and Koontz have opined that: “when dealing with complex problems effecting numerous people, it is often necessary to compromise on some points. But compromises by their very nature require participants to sacrifice some of their interests. This can lead to considerable dissatisfaction or frustration. These ‘human costs’ are often considerable” even though these cannot be measured in terms of money.

15.13.7. Evaluation of Alternatives and Selection of a Course of Action:

The next step in the decision-making process is evaluating each of the alternatives generated in the previous step. Usually each alternative has to be assessed to determine its feasibility, its satisfactoriness, and its consequences. This step lies at the heart of the decision-making process. All the previous steps have been of a preparatory nature and it is in this step that the manager finally decides what to do.

This crucial stage has the following three distinct but closely interrelated phases:

(i) Determining feasible alternatives:

In case where a large number of alternatives have been generated, it is quite likely that many of them will not appear to be feasible. There are two reasons for this. Either the resources necessary to implement the alternatives are not available. Alternatively there may be prohibitive constraints.

As Boone and Kurtz have argued: “if judgement was suspended during the creative

generation of alternatives in the previous step, most of the alternatives generated would fall into the infusible category. Separating the feasible alternatives from the infeasible ones saves time, since the decision maker can then evaluate only those alternatives that are likely to be chosen."

(ii) Evaluation of alternatives:

The evaluation of alternatives is no doubt a complex exercise. In fact many of the operations research techniques developed during the last few decades are methods of determining the relative efficiency of various alternatives.

Alvar Elbing has proposed the following five rules for evaluating alternatives:

1. A solution should have substantial quality so that it can meet organisational goals.

2. A solution has to be acceptable to those affected by it and to those who must implement it.

3. A solution has to be evaluated in terms of the anticipated responses to it.

4. The risks of each alternative must be considered.

5. The choice of solution should focus on present alternatives, not past possibilities.

Is quality consistent with goals?

In order to assess the quality of a solution we have to reintroduce the concepts of efficiency and effectiveness. In fact, the quality of a solution has these two dimen-sions. Efficiency may be reinterpreted as the ratio of output to inputs. In other words, it is a measure of organisational productivity. It therefore lies at the heart of business cost-benefit analysis.

On the contrary, effectiveness is a measure of the extent to which an alternative meets the stated objective (regardless of the costs involved). Before attempting to evaluate the quality of any alternative, it is absolutely essential for the decision-maker to first establish the extent to which each of these criteria will be used.

(iii) Choosing the Most Appropriate Alternative:

After evaluating the alternatives properly it is necessary to choose the alternative which is accept-able to those who must implement it and those who have to bear the consequences of the decision. Failure to meet this condition often results in the failure of the whole decision-making process to solve problems. In fact, choosing the best alternative in terms of facilities, satisfactoriness and affordable consequences is the real crux (or the essence) of the decision-making process.

A related point may be noted in the context. It is possible to assess the acceptability and efficacy (efficiency) of a proposed solution by considering the anticipated responses to it. Such a response refers to the reaction of the organisation and its individual members to an alternative that has been chosen. This should be of critical concern to the manager or decision maker.

The solution is simple to find: even a technically mediocre solution may prove to be 'effective' (in the sense defined above) if it is implemented with enthusiasm and dedication. On the contrary, the technically correct alternative may fail to evolve sufficient response or succeed if it is implemented in half-hearted and haphazard fashion.

This explains why most writers on management stress the importance of including as many members of the organization as feasible in the decision-making process. True, "participation in problem solving by organizational members should increase their receptiveness to the chosen alternative."

It is also necessary to consider the various types of risks associated with each alternative. In fact, different risks are involved for different individuals and groups in the organization. It may be stressed at this stage that the differences among those who make decision, those who implement them and those who must live on them should not be minimised.

15.13.8. Implementation

After one or more alternatives have been selected, the manager must put the alternative or alternatives into effect. In some situations, implementation may be fairly easy; in other situations it may be quite difficult. However, since most managerial problems are intimately concerned with the human element in the organisation, implementation of solution is no doubt a complex exercise.

It is to be noted that so far no generalised rules have been developed that deal with managing the implementation phase.

However, three questions must be answered at the phase:

Firstly, what should the internal structure of implementation be? In other words, what should be done? When? By whom? Since the solution of most managerial problems requires the combined effort of various members of the organization, each must understand what role he (she) has to play during each phase of the implementation process.

Secondly, how can the manager reward organization members for participating in the implemen-tation of the proposed solution? Decisions are no doubt made by managers but these are carried out by other members of the organization. So managers must ensure that those who are responsible for implementation have some stake — financial or otherwise — in the success of the solution.

Thirdly, how provisions for evaluation and modification of the chosen solution during the implementation process be made? As implementation of solution proceeds, organization members should be able to modify the solution based on what they learn during implementation.

But unless some specific provision is made for modification of the chosen solution, the chosen alternative may be left untouched and implemented without any thought of possible modification — even in those situations where minor adjustments would produce better solutions.

The key to effective implementation is action planning, a well thought out, step-by-

step descrip-tion of the programme. Some appropriate techniques for solving organizational problems arising from decision situations are tactical plans, operational plans and programmes, and standing plans. A programme, for example, might be developed for the sole purpose of implementing a course of action for solving an organizational problem.

Another problem to consider when implementing decisions is people's resistance to change. There are various reasons for such resistance such as insecurity, inconvenience and fear of the unknown. Hence, it will be judicious on the part of managers to anticipate potential resistance at various stages of the implementation process.

Managers should also recognise that "even when all alternatives have been evaluated as precisely as possible and consequences of each alternative weighed, it is likely that unanticipated conse-quences will also arise. Unexpected cost increases a less-than-perfect 'fit' with existing organisational subsystems, unpredicted effects on cash-flow or operating expenses, or any number of other situations could develop after the implementation process has begun".

15.13.9. Feedback

Feedback is "a necessary component of the decision process, providing the decision maker with a means of determining the effectiveness of the chosen alternatives in solving the problem or taking advantage of the opportunity and moving the organisation closer to the attainment of its goals."

In order to make such an evaluation of the effectiveness of a possible decision, the following three conditions must be fulfilled:

Firstly, there must exist a set of standards which act as yardstick against which to compare performance. For example, if the sales goal of a company in the next quarter is Rs. 2 lakhs more than the current quarter, the relevant standard is present sales turnover plus Rs. 2 lakhs. Likewise if a company adopts a zero defect programme, a zero rejection rate for output becomes the relevant standard.

Secondly, performance data must be readily available so that the comparison to standards may be made. The chief approach to formulating the data collection process is the design of management information systems.

Finally, it is absolutely essential to develop a data analysis strategy. Such a strategy includes a formal plan which outlines how the data will be used. However, one unfortunate characteristic of most data are never used for decision-making purposes. The problem is not insoluble.

In fact, "managers who know exactly how the data are to be analysed will be able to specify the types of the data they need, the most preferred format, and the time sequence in which they are needed." Such advance specifications are likely to act as aids in reducing the mass of useless data that are often collected.

15.13.10. Follow-up and Evaluation:

As the final step in the decision-making process, managers should be very sure to evaluate the effectiveness of their decision. That is, they should make sure that the alternatives chosen in step 5 and implemented in step 6 have accomplished the desired result.

When an implemented alternative fails to work, the manager has to respond quickly. There are several ways of doing it. One of the alternatives that was identified previously (the second or third choice) could be adopted.

Alternatively, the manager might recognise that the situation was not correctly defined to start with and begin the decision-making process all over again. Finally, the manager might decide that the alternative originally chosen is in fact appropriate, but that it simply has not yet had time to work or should be implemented in a different way.

IT shows an effective process for evaluating alternatives. Prior to the actual decision, exist-ing conditions relevant to the deci-sion itself are observed, assessed and measured. Finally, a post deci-sion observation should be made to determine how successful the decision was in solving the original problem.

15.14 Summary

Traditionally, the IT department has been responsible for building, operating, and maintaining a capable, efficient, and stable IT infrastructure. They have solely borne the responsibility for organizing all things related to technology within the organization. However, this traditional role is undergoing a transformation, especially with respect to decision-making. Irrespective of these changes, the IT department still plays a crucial role because it is the only one that has a comprehensive view of the entire technology stack, systems, security, and compliance requirements.

Involving end-users in the decision-making process, in fact, can relieve some of the IT department's burden, allowing them to focus on other critical matters such as security, data protection, and compliance. A collaborative approach to decision-making also allows the IT department to shed its image of technology gatekeeper and to become a productivity partner for everyone in the organization.

15.15 Key words

Database management system (DBMS)

A DBMS serves as a data bank for the DSS. It stores large quantities of data that are relevant to the class of problems for which the DSS has been designed and provides logical data structures (as opposed to the physical data structures) with which the users interact.

Model-base management system (MBMS)

The role of MBMS is analogous to that of a DBMS. Its primary function is providing independence between specific models that are used in a DSS from the applications that use them.

Dialog generation and management system (DGMS)

The main product of an interaction with a DSS is insight. As their users are often managers who are not computer-trained, DSSs need to be equipped with intuitive and easy-to-use interfaces.

User Interface

The user interface includes tools that help the end-user of a DSS to navigate through the system.

Knowledge Base

The knowledge base includes information from internal sources (information collected in a transaction process system) and external sources (newspapers and online databases).

15.16 Self Assessment Questions

1. Briefly discuss the Purpose of Decision Support system
2. Explain the Components of Decision Support system
3. Describe the Types of Decision support system
4. Discuss the Fundamental components of DSS
5. Analyze the Context and Conditions of Decision Making
6. Outline the Decision-Making at Different Levels in the Organisation

15.17 Suggested Readings

1. Lucas: The Analysis, Design and Implementation of Information Systems, McGraw-Hill co., New Delhi.
2. Eigenhaun, Edward A. & Mc Corduck, Pamela, : The Fifth Generation : Artificial Intelligence and Japan 's Computer Challenge to the World, Singet Books, New York
3. Sadagopan : Management Information Systems, Prentice Hall of India Pvt. Ltd., New Delhi .
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LESSON -16

DECISION TREE

Learning Objectives

- ✓ To study the Models of Decision Making
- ✓ To Understand the Conditions of Decision Making
- ✓ To Learn the Models of Decision Making
- ✓ To Elaborate the Benefits of Using Decision making tools
- ✓ To Outline the Perspective of Decision Tree

Structure

16.0 Introduction

In today's dynamic world business firms have to take a number of decisions every now and then. Managers know how important decision-making is from the organisational point of view. For example, in research and development management has to decide whether to pursue one or multiple design strategies

Likewise, the production department has to decide whether to manufacture all of the electrical components or to subcontract to other firms. Similarly, the financial manager has to decide whether to invest in a new plant or to lease. Again, marketing managers have to determine the appropriate production mix with regard to price and promotion: if multiple products are produced, what should be the price range among different products? Finally, in personnel decisions have to be made about new and different pay scales and the likely impact on current wage rates.

None of the decisions is simple and it is virtually impossible for decision makers to account fully for all of the factors that will influence the outcome of the decision. As a result, the future is surrounded by uncertainty and risks have to be assumed.

Decision making is an integral part of all marginal activities including organising, leading and controlling. However, decision-making is usually most closely associated with the planning function, inasmuch as it is an important tool for most planning activities. Everyday we have to make one decision or the other. Managers are faced with a wide range of decisions on any given day. For a manager the ability to make the best professional decision is the key to success. In fact, management is basically a study of the decision-making process within an organisation.

16.1 Play Models of Decision Making

The ability to make good decisions is the key to successful managerial performance. Managers of most profit-seeking firms are always faced with a wide range of important decisions in the areas of pricing, product choice, cost control, advertising, capital investments, dividend policy and so on. Managers in the not-for-profit and public enterprises are faced with a similarly wide range of decisions. For example, the Dean of the Faculty of Indian Institute of Management, Calcutta, must decide how to allocate funds among such competing needs as travel, phone services, secretarial support, and so on.

Longer-range decisions must be made concerning new facilities, new programmes, the purchase or lease of a new computer and the decision to establish an executive development centre. Public sector managers or government agencies face such decisions as the construction of a new bridge over river Hooghly, the location of the bridge, the need to support public transit systems, the enforcement of anti-monopoly laws (such as the M.R.T.P. Act) and the economic viability of setting up a Second Mumbai Airport.

A manager has always to take decisions of one sort or another. The decisions may be such as where to invest money, where to set up a new plant or warehouse, how to deal with to invest money, where to set up a new plant or warehouse, how to deal with an employee who is invariably late, or what subject should be brought into focus in the next departmental meeting. Whatever may be the nature and dimension of the problem at hand, the manager has to decide what actions need to be taken or has to arrange for others to decide.
Decision making is perhaps the most important component of a manager's activities. It plays the most important role in the planning process.

As Stoner puts it:

"Planning involves the most significant and far-reaching decisions a manager can make. When managers plan, they decide such matters as what goals or opportunities their organization will pursue, what resources they will use, and who will perform each required

task. When plans go wrong or out of track, managers have to decide what to do to correct the deviation. In fact, the whole planning process involves managers constantly in a series of decision-making situations. How good their decisions are will largely determine how effective their plan will be."

Definition of Decision Making:

Most writers on management feel that management is basically decision-making. They argue that it is only through making decisions (about planning, organizing, directing and controlling) that an organisation can be enabled to accomplish its short term and long term goals. In this article we shall discuss how managers can best go about reaching good (rational) decisions.

Decision making can be defined as making a choice among alternative courses of action or as the process of choosing one alternative from among a set of rational alternatives. This definition has three different but interrelated implications. See Fig.8.1.

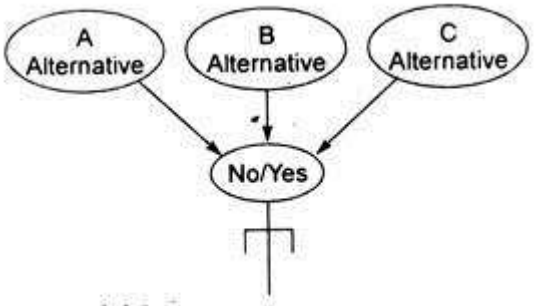

Fig.8.1 : The Decision-making

Effective decision-making requires a clear understanding of the situation. Most people think that an effective decision is one that optimism some factor such as profits, sales employee welfare, or market share. In some situations, however, the effective decision may be one that minimizes loss, expenses, or employee turnover. It may even mean selecting the best method for going out of business or terminating a contract.

1. When managers make decisions they exercise choice — they decide what to do on the basis of some conscious and deliberate logic or judgement they have made in the past.

2. When making a decision managers are faced with alternatives. As Stoner puts it: "It does not take a wise manager to reach a decision when there are no other possible choices. It does require wisdom and experience to evaluate several alternatives and select the best one."

3. When making a decision managers have a purpose. As R. W. Morell has put it, there is hardly any reason for carefully making a choice among alternatives unless the decision has to bring them closer to same goal.

Therefore in this article the stress will be on the formal decision-making process, i.e., how managers proceed systematically to reach logical decisions that can help them in the best possible way to reach their goals.

The implication is simple enough: Managers are almost always faced with a problem or opportunity. So they propose and analyse alternative courses of action and finally make a choice that is likely to move the organisation in the direction of its goals.

We noted that effective decision requires an understanding of the situation. In a like manner,

the effectiveness of any decision has to be assessed in terms of the decision-maker's underlying goal.

16.2 The Context of Decision-Making

Here, we treat decision-making as essentially an individual process, but a process that occurs in an organisational context. It illustrates this point. The individual decision-maker lies at the centre of the process, but any given decision is likely to be influenced by a number of other people, departments and organizations It shows such important influences as supervisors, peers and colleagues, subordinates, other organizational components (such as other departments and their managers), and the environment (including elements of the task environment, such as competitors and suppliers, as well as general environmental factors such as technology and the economy).

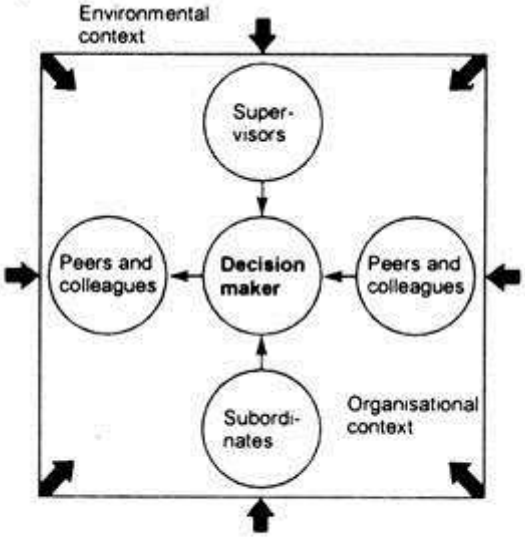

Fig.8.2 : The Decision-making context

16.3 Conditions for Decision-Making

Although decision-making is essentially an individual process, the surrounding conditions can vary widely. Organisational decisions are made under three conditions, viz., certainly, risk and uncertainty. These conditions are represented in Fig. 8.3.

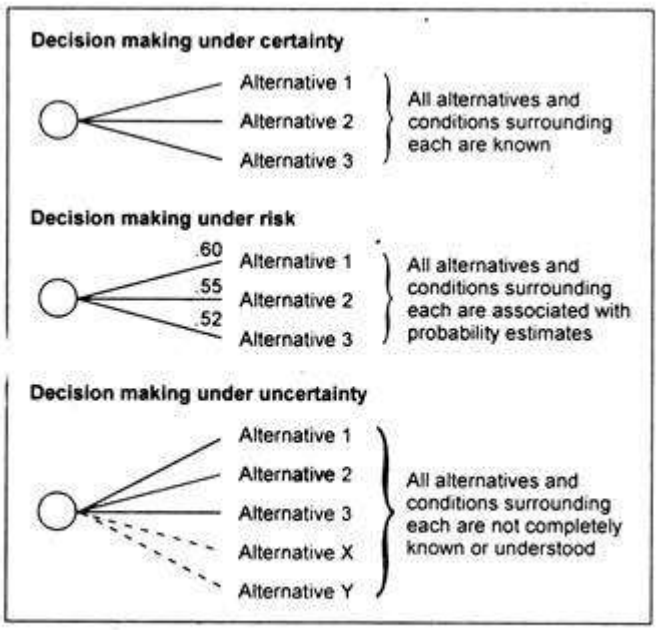

Fig.8.3 : Decision-making conditions

16.3.1 Decision Making Under Certainty:

When managers know with certainty what their possible alternatives are and what conditions are associated with each alternative, a state of certainty exists.

16.3.2 Decision Making under Risk:

A more realistic decision-making situation is a state of risk. Under a state of risk, the availability of each alternative and its potential pay-offs (rewards) and costs are all associated with profitability estimates. It is, therefore, quite obvious that the key element in decision-making under a state of risk is accurately determining the probabilities associated with each alternative.

16.3.3 Decision Making under Uncertainty:

However, most important and strategic decisions in modern organisations are taken under conditions of uncertainty. A state of uncertainty refers to a situation in which the decision maker does not know what all the alternatives are, and the risks associated with each, or what consequences each is likely to have.

This complexity arises from the complexity and dynamism of today's organisations and their environments. All successful organisations have made various effective decisions under uncertainty. The key to effective decision-making under uncertainty is to acquire as much relevant information as possible and to approach the situation from a logical and rational perspective. Intuition, judgement and experience always play a very important role in decision-making under uncertain conditions.

16.4 Types of Decisions:

As managers "we will make different types of decisions under different circumstances. When deciding whether or not to add a new wing to the administration building, or where to build a new plant, we will have to consider our choice carefully and extensively. When deciding what salary to pay a new employee, we will usually be able to be

less cautious. Similarly, the amount of information we will have available to us when making a decision will vary. When choosing a supplier, we will usually dose on the basis of price and past performance. We will be reasonably confident that the supplier chosen will meet our expectations. When deciding to enter a new market, we will be much less certain about the success of our decision. For this reason, we will have to be particularly careful making decisions when we have little past experience or information to guide us."

In short, the nature and circumstances of a decision can vary enormously. Managers have to vary their approach to decision-making, depending on the particular situation involved. For our purposes, it will be useful to distinguish between situations that call for programmed decisions and those that call for non-programmed decisions. Business managers have to make various types of decisions. Such decisions can be placed into three broad categories: technical decisions, managerial decisions and institutional decisions.

16.5 Models for Decision Making

16.5.1 Technical Decisions

In every organisation there is need to make decisions about core activities. These are basic activities relating directly to the 'work of the organisation'. The core activities of Oil India Ltd. would be exploration, drilling, refining and distribution. Decisions concerning such activities are basically technical in nature. In general, the information required to solve problems related to these activities is generally concerned with the operational aspects of the technology involved.

In short, technical decisions are concerned with the process through which inputs such as people, information or products are converted into outputs by the organisation.

16.5.2 Managerial Decisions

Such decisions are related to the co-ordination and support of the core activities of the organisation.Managerial decision-making is also concerned with regulating and altering the relationship between the organisation and its external (immediate) environment. In order to maximize the efficiency of its core activities it becomes absolutely essential for management to ensure that these actions are not unduly disturbed by short-term changes in the environment.

This explains why various organisations often build up inventories and forecasting of short-term changes in demand and supply conditions are integral parts of managerial decision-making.

16.5.3 Institutional Decisions:

Institutional decisions concern such diverse issues as diversification of activities, large-scale capital expansion, acquisition and mergers, shifts in R & D activities and various other organisational choices. Such decisions obviously involve long-term planning and policy formulation.

In the words of Boone and Koontz: "Institutional decisions involve long-term planning and policy formulation with the aim of assuring the organisation's survival as a productive part of the economy and society." The implication is clear: if an organisation is to thrive in the long run as a viable organisation, it must occupy a useful, productive place in the economy and society as a whole.

With changes in society and in its economic framework, an organisation must adapt itself to such changes. Otherwise it may cease to exist. Due to shortage of traditional sources of energy the passenger car industry of the U.S. was reeling under recession from 1973

onwards. Some automobile companies faced with falling demand for petrol-operated cars have produced battery-operated motor cars.

Managers in every organisation are faced with these three types of decisions, viz., technical, managerial and institutional. Table 8.1 illustrates each type of decision for two different organisations: one profit-seeking firm (an oil company) and non-profit seeking firm (an oil company) and one non-profit organisation (a hospital).

Table 8.1 : Two Organisations and Three Kinds of Decisions

Institutional Decisions	Managerial Decisions	Technical Decisions
Should we bid on the offshore drilling lease or diversify into coal or uranium ?	What land/sea leases should we choose ?	Where should we drill the well ? Dig the mine ?
How should we react to the president's new energy program ?	How much should we spend on public relations versus lobbying ?	Which members of Congress should we concentrate ?
Should we add a radiation therapy unit to the facilities ?	How will we staff the unit ? Where will it go ?	What should the treatment schedule for this patient be ?
Should we develop an outreach capability beyond our present emergency room facilities ?	How do we integrate present personnel into the new programme ?	Should health education be carried out in the clinic ?

16.6 Decision-Making at Different Levels in the Organisation

A study of the decision-making in different organisations reveals that the three types of decisions listed above are not evenly spread throughout the organisation. In general most institutional decisions are mostly made at the supervisory level. This point is illustrated in Fig.8.4.

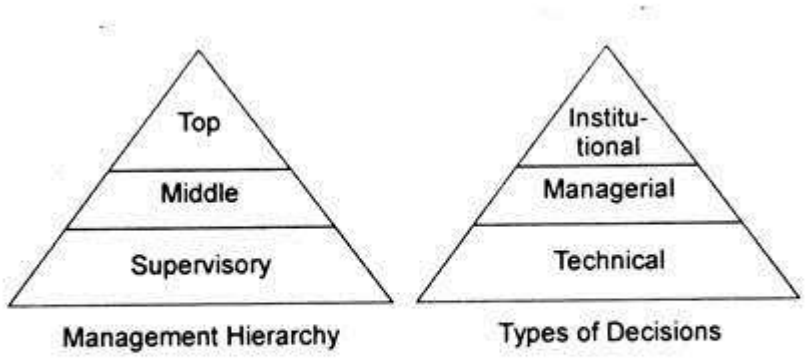

Fig.8.4 : The relationship between types of decisions and the management hierarchy

It gives an indication of the relative number of each type of decision made at each level in the organisations. However, the categories should not be treated as exclusive. For example, the production manager of a machinery manufacturing firm like the Texmaco might primarily be engaged in technical decisions, while the legal adviser of the company might be involved in institutional matters.

Programmed and Non-Programmed Decisions

Nobel Laureate H. A. Simon has distinguished between two types of decisions, viz., programmed and non-programmed moved decisions. He has made the point that decisions differ not only in their content but also in terms of their relative uniqueness. By the term 'relative uniqueness' he means the degree to which a problem or decision (1) has been seen before; (2) occurs frequently and at regular intervals; and (3) has been solved or resolved in a satisfactory manner.

According to Simon, programmed decisions are those which involve simple, common, frequently occurring problems that have well-established and understood solutions. On the contrary, non- programmed decisions are those involving new, often unusual or novel problems.

In the words of Stoner:

"Programmed decisions are those that are made in accordance with some habit, rule or procedure. Every organisation has written or unwritten policies that simplify decision-making in a particular situation by limiting or excluding alternatives."

A few examples of such decisions may now be given. In most situations managers will not have to worry about what to pay a new employee because most organisations have an established salary structure (or pay policy) for any position. (Of course, salary of highly skilled or top management is often negotiable. But these are exceptions rather than the rule).
In a like manner managers will not generally have to think about the routine problems they face every day. Their habits, or those of their peers, will help them decide quickly what to do about them.

There is no denying the fact that programmed decisions limit the freedom of managers to a considerable extent. In other words, managers hardly enjoy any discretion in matters involving programmed decisions set managers, decide what to do. This implies that programmed decisions set managers free on most occasions.

The policies, rules or procedures by which managers make decisions free them of the need to find out new solutions to every problem they face. For instance, it would really be time-consuming to decide how to handle customer complaints on an individual basis. Adoption of routine procedures such as permitting customers to exchange unsuitable merchandise would really help matters.
Since managers regularly have a series of decisions to make, organisations have to develop varying decision rules, programmes, policies, and procedures to use. Existing pay scales are used as guideline to fix the starting salary of a new factory guard or a new security officer. Similarly, when inventory of raw materials occurs.

What can be said in favour of programmed decisions is that such decisions can be made "quickly, consistently and inexpensively since the procedures, rules and regulations eliminate the time-consuming process of identifying and evaluating alternatives and making a new choice each time a decision is required. While programmed decisions limit the flexibility of managers, they take little time and free the decision maker to devote his or her efforts to unique, non-programmed decisions. It is perhaps easiest for managers to make programmed decisions."

It is perhaps easiest for managers to refer to a policy rather than think of some problem and suggest solution. Effective managers usually rely on policy as a time saver. But they must remain alert for any exceptional case(s). For example, in case of a multi-product firm like the Godrej, the company policy may put a ceiling on the advertising budget for each product.
However, a particular product, say Cinthol, may demand an expensive advertising campaign to counter a competitor's aggressive marketing strategy. In such a situation a programmed decision — that is a decision to advertise the product in accordance with budget guidelines —

may prove to be wrong. Thus when a situation calls for a programmed decision managers must ultimately make use of their own judgement.

Non-programmed decisions, as Stoner has put it, are **"those that are out of the ordinary or unique. If a problem is complex or exceptional, or, if it has not come up often enough to be covered by a policy, it must be handled by a non-programmed decision."**

Such decisions are needed to solve problems like how to allocate an organisation's resources, what to do about a failing product line, how community relations should be improved, and almost all significant problems a manager faces. In Table 8.2, we prepare a list of the traditional and modern techniques of decision-making.

Table 8.2 : Techniques Of Decision-making

Types of Decision	Decision-making Techniques	
	Traditional	Modern
Programmed: Routine, repetitive decisions. Organisation develops specific processes for handling the processes	1. Habit 2. Clerical routine: Procedures 3. Organisation structure: Common expectations A system of Subgoals Well-defined informational channels	1. Operations research: Mathematical Models Computer simulation 2. Electronic data processing
Nonprogrammed: One-shot, ill-structured, novel policy decisions. Handled by general problem-solving processes	1. Judgment, institution, and creativity 2. Rules of thumb 3. Selection and training of executives	Heuristic problem-solving technique applied to: a. Training human decision makers b. Constructing heuristic computer programme

In those organisations and decision situations where non-programmed decisions are the rule, the creation of alternatives and the selection and implementation of the most appropriate one becomes the distinction between effective and ineffective managers is drawn on the basis of their ability to make good non- programmed decisions.

However, managers are often evaluated on the basis of their ability to solve problems, to apply creativity and judgement to the solution of problems and to make decisions in a logical, step-by-step manner. Since established procedures are of little use for making such decisions, new solutions are to be found out.

This explains why most management training programmes are directed towards improving a manager's ability to make non-programmed decisions by teaching them how to take such decisions.

16.7 Decision-Making Tools

Decision-making tools are methods and exercises that individuals can use to approach problem-solving and choice-based scenarios effectively. These tools can often help guide you through the following phases of the decision-making process:

Determination: This phase refers to the stage in the decision-making process through which you identify what your options and goals are.
Analysis: After determining your options and goals, you can conduct research, gather key information and analyze the impact of each potential choice.
Evaluation: With a full analysis of the actions you can take and any alternatives you've generated, you can enter the evaluation stage through which you determine the value of each option, including its benefits and drawbacks.
Selection: Using the data you've gained through your analysis and evaluation phases, you can

make an informed decision and select an option you identified through the determination stage.

Assessment: After you make a decision, you can later assess your actions and examine them to understand the short-term and long-term impacts of your choice.

Related: Methodologies for Decision-Making (With Definitions and Examples)

16.8 Benefits of using decision-making tools

There are various benefits you can enjoy by using decision-making tools. These exercises and methods can help you better understand the entire decision-making process and closely examine the choices available to you in your specific situation. From here, you can analyze your options, evaluate them and use a data-driven approach to determine what course of action is best for you.

Decision-making tools can provide you with the ability to make informed selections you can feel confident about regardless of the type of choice with which you're faced. Over time, using these tools consistently can help you strengthen your innate decision-making skills and become more adept at problem-solving and overcoming challenges.

16.8.1. Decision matrix

Decision matrixes can help you evaluate the varying options of a decision comprehensively. These tools are essentially tables with multiple columns, including one that contains each option and others that contain all other factors that play into a decision. Using this information, you can rank all factors by importance and score each option to identify which is best suited for your needs.

16.8.2. Pro/con lists

Pro/con lists, or t-charts, allow you to compare all the advantages and disadvantages of individual options. To use this method, you can create a list of all the potential impacts of a decision and weigh their significance to better understand your choices. This tool is typically best suited for decisions with few options.

16.8.3. Decision tree

Decision trees use statistical analysis and can help you better comprehend problems that require a multistage decision-making process. This tool often takes the form of a graph or model that involves the assessment of various options and their outcomes. Decision trees can be highly useful when making decisions that have some level of uncertainty.

16.8.4. Cost-benefit analysis

Cost-benefit analyses are useful when making decisions that have financial ramifications. This method can help you assess the various costs of an option and the benefits that may result from it. From here, you can determine what decision has the greatest benefit and the lowest cost to maximize profit.

16.8..5. Multivoting technique

Multivoting is a technique that can be helpful in making collaborative decisions within a group of stakeholders. This exercise allows groups to narrow their options down by voting on which selection suits their individual needs best. The group typically votes until they collectively reach a final decision.

16.8.6. Influence diagram

Influence diagrams are tools through which you can weigh all the potential variables involved in a decision. This tool weighs selections, uncertainties and objectives and their interconnectivity mathematically. You can use these diagrams as an alternative to decision trees when inferring and assessing the potential influence of options and their outcomes.

16.8.7. Trial and error

Trial and error is an active decision-making tool that allows individuals to test various options and assess their outcomes. The trial-and-error method involves piloting different options and evaluating their benefits in real-time. This method is typically most suitable when approaching small, low-impact and reversible decisions.

16.8.8. Pareto analysis

The Pareto analysis, named after economist Vilfredo Pareto, is a method of examining the options of large-impact, multistep decision-making processes. Through this method, you can rank options by priority by determining which may have the most impact. From here, you can maximize impact, which can be highly beneficial when making organizational or business decisions.

16.8.9. SWOT analysis

Strengths, weaknesses, opportunities and threats (SWOT) analysis helps individuals evaluate the varying situational outcomes of options when making a decision. This method can help you identify the disadvantages and advantages of potential choices through an in-depth, multifaceted examination. From here, you can maximize strength and opportunity and minimize weakness and threat.

16.8.10. PEST analysis

Political, economic, social and technological (PEST) analysis can allow you to examine the many external factors that may influence the outcome of a decision. This method is commonly useful when faced with problems that require you to pay attention to current trends and predict future ones. For instance, organizations may use this tactic to make decisions with the goal of becoming more competitive in a given market.

16.8.11. Feasibility study

Feasibility studies involve the imagination of potential outcomes of a decision-making process. Through this method, you can model the various impacts made by each option available to you. From here, you may be able to decide what strategies can help you maximize positive outcomes while maintaining overall feasibility.

16.9 Decision Tree

Decision Trees (DTs) are a non-parametric supervised learning method used for classification and regression. The goal is to create a model that predicts the value of a target variable by learning simple decision rules inferred from the data features. A tree can be seen as a piecewise constant approximation.

For instance, in the example below, decision trees learn from data to approximate a sine curve with a set of if-then-else decision rules. The deeper the tree, the more complex the decision rules and the fitter the model.

Some advantages of decision trees are:
Simple to understand and to interpret. Trees can be visualized.

Requires little data preparation. Other techniques often require data normalization, dummy variables need to be created and blank values to be removed. Note however that this module does not support missing values.

The cost of using the tree (i.e., predicting data) is logarithmic in the number of data points used to train the tree.

Able to handle both numerical and categorical data. However, the scikit-learn implementation does not support categorical variables for now. Other techniques are usually specialized in analyzing datasets that have only one type of variable. See algorithms for more information.

Able to handle multi-output problems.

Uses a white box model. If a given situation is observable in a model, the explanation for the condition is easily explained by boolean logic. By contrast, in a black box model (e.g., in an artificial neural network), results may be more difficult to interpret.

Possible to validate a model using statistical tests. That makes it possible to account for the reliability of the model.

Performs well even if its assumptions are somewhat violated by the true model from which the data were generated.

The disadvantages of decision trees include:
Decision-tree learners can create over-complex trees that do not generalize the data well. This is called overfitting. Mechanisms such as pruning, setting the minimum number of samples required at a leaf node or setting the maximum depth of the tree are necessary to avoid this problem.

Decision trees can be unstable because small variations in the data might result in a completely different tree being generated. This problem is mitigated by using decision trees within an ensemble.

Predictions of decision trees are neither smooth nor continuous, but piecewise constant approximations as seen in the above figure. Therefore, they are not good at extrapolation.

The problem of learning an optimal decision tree is known to be NP-complete under several aspects of optimality and even for simple concepts. Consequently, practical decision-tree learning algorithms are based on heuristic algorithms such as the greedy algorithm where locally optimal decisions are made at each node. Such algorithms cannot guarantee to return the globally optimal decision tree. This can be mitigated by training multiple trees in an ensemble learner, where the features and samples are randomly sampled with replacement.

There are concepts that are hard to learn because decision trees do not express them easily, such as XOR, parity or multiplexer problems.
Decision tree learners create biased trees if some classes dominate. It is therefore

recommended to balance the dataset prior to fitting with the decision tree.

16.10 Summary

A decision-making model describes the method a team will use to make decisions. The most important factor in successful decision-making is that every team member is clear about how a particular decision will be made. Who will be making the decision? How will team members be involved? By when? Knowing these things allows team members to be fully informed participants in discussions - "Will we be giving input to the team leader so he can make the decision?" or "Will we need to discuss this topic and come to agreement during this meeting?"

Knowing how a particular decision will be made can also help a team plan their meeting agendas more effectively and lead to more collaborative team process. Most importantly, understanding how decisions will be made helps to build support for the final decision and active commitment to that decision's implementation. Because effective teams work towards the fullest participation of each member, teams often use some version of a consensus decision-making model.

16.11Key words

Technical Decisions

In every organisation there is need to make decisions about core activities. These are basic activities relating directly to the ‘work of the organisation

Managerial Decisions

Such decisions are related to the co-ordination and support of the core activities of the organisation. Managerial decision-making is also concerned with regulating and altering the relationship between the organisation and its external (immediate) environment

Institutional Decisions:

Institutional decisions concern such diverse issues as diversification of activities, large-scale capital expansion, acquisition and mergers, shifts in R & D activities and various other organisational choices. Such decisions obviously involve long-term planning and policy formulation.

Decision matrix

Decision matrixes can help you evaluate the varying options of a decision comprehensively

Trial and error

Trial and error is an active decision-making tool that allows individuals to test various options and assess their outcomes

SWOT analysis

Strengths, weaknesses, opportunities and threats (SWOT) analysis helps individuals evaluate the varying situational outcomes of options when making a decision.

Political, economic, social and technological (PEST) analysis can allow you to examine the many external factors that may influence the outcome of a decision. The Pareto analysis, named after economist Vilfredo Pareto, is a method of examining the options of large-impact, multistep decision-making processes

16.12Self Assessment Questions

1. Briefly Discuss the Models of Decision Making
2. Examine the Conditions of Decision Making
3. Explain the Models of Decision Making
4. Elaborate the Benefits of Using Decision making tools
5. Outline the Perspective of Decision Tree

16.13 Suggested Readings

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LESSON -17

DATA BASE MANAGEMENT SYSTEM

Learning objectives

- ✓ To understand the Data base System
- ✓ To Know the Advantages of DBMS
- ✓ To Learn the Disadvantages of DBMS
- ✓ To Study the Data lifecycle Stages

Structure

17.0 Introduction

A database-management system (DBMS) is a collection of interrelated data and a set of programs to access those data. This is a collection of related data with an implicit meaning and hence is a database. The collection of data, usually referred to as the database, contains information relevant to an enterprise. The primary goal of a DBMS is to provide a way to store and retrieve database information that is both convenient and efficient. By data, we mean known facts that can be recorded and that have implicit meaning. The management system is important because without the existence of some kind of rules and regulations it is not possible to maintain the database. We have to select the particular attributes which should be included in a particular table; the common attributes to create relationship between two tables; if a new record has to be inserted or deleted then which tables should have to be handled etc. These issues must be resolved by having some kind of rules to follow in order to maintain the integrity of the database. Database systems are designed to manage large bodies of information. Management of data involves both defining structures for storage of information and providing mechanisms for the manipulation of information. In addition, the database system must ensure the safety of the information stored, despite system crashes or attempts at unauthorized access. If data are to be shared among several users, the system must avoid possible anomalous results. Because information is so important in most organizations, computer scientists have developed a large body of concepts and techniques for managing data.

A Database management system is a computerized record-keeping system. It is a repository or a container for collection of computerized data files. The overall purpose of DBMS is to allow the users to define, store, retrieve and update the information contained in the database on demand. Information can be anything that is of significance to an individual or organization.

Databases touch all aspects of our lives. Some of the major areas of application are as follows:

1. Banking

2. Airlines

3. Universities

4. Manufacturing and selling

5. Human resources

17.1 Enterprise Information

Sales: For customer, product, and purchase information.

Accounting: For payments, receipts, account balances, assets and other accounting information.

Human resources: For information about employees, salaries, payroll taxes, and benefits, and for generation of paychecks.

Manufacturing: For management of the supply chain and for tracking production of items in factories, inventories of items inwarehouses and stores, and orders for items.

Online retailers: For sales data noted above plus online order tracking,generation of recommendation lists, and maintenance of online product evaluations.

17.2 Banking and Finance

Banking: For customer information, accounts, loans, and banking transactions.

Credit card transactions: For purchases on credit cards and generation of monthly statements.

Finance: For storing information about holdings, sales, and purchases of financial instruments such as stocks and bonds; also for storing real-time market data to enable online trading by customers and automated trading by the firm.

Universities: For student information, course registrations, and grades (in addition to standard enterprise information such as human resources and accounting).

Airlines: For reservations and schedule information. Airlines were among the first to use databases in a geographically distributed manner.

Telecommunication: For keeping records of calls made, generating monthly bills, maintaining balances on prepaid calling cards, and storing information about the communication networks.

17.3 Purpose of Database Systems

Database systems arose in response to early methods of computerized management of commercial data. As an example of such methods, typical of the 1960s, consider part of a university organization that, among other data, keeps information about all instructors, students, departments, and course offerings. One way to keep the information on a computer is to store it in operating system files. To allow users to manipulate the information, the system has a number of application programs that manipulate the files, including programs to:

i. Add new students, instructors, and courses
ii. Register students for courses and generate class rosters
iii. Assign grades to students, compute grade point averages (GPA), and generate transcriptsSystem programmers wrote these application programs to meet the needs of the university.

New application programs are added to the system as the need arises. For example, suppose that a university decides to create a new major (say, computer science).As a result, the university creates a new department and creates new permanent files (or adds information to existing files) to record information about all the instructors in the department, students in that major, course offerings, degree requirements, etc. The university may have to write new application programs to deal with rules specific to the new major. New application programs may also have to be written to handle new rules in the university. Thus, as time goes by, the system acquires more files and more application programs.

This typical file-processing system is supported by a conventional operating system. The system stores permanent records in various files, and it needs different application

programs to extract records from, and add records to, the appropriate files. Before database management systems (DBMSs) were introduced,organizations usually stored information in such systems. Keeping organizational information in a fileprocessing system has a number of major disadvantages:

17.3.1 Data redundancy and Inconsistency

Since different programmers create the files and application programs over a long period, the various files are likely to have different structures and the programs may be written in several programming languages. Moreover, the same information may be duplicated in several places (files). For example, if a student has a double major (say, music and mathematics) the address and telephone number of that student may appear in a file that consists of student records of students in the Music department and in a file that consists of student records of students in the Mathematics department. This redundancy leads to higher storage and access cost. In addition, it may lead to data inconsistency; that is, the various copies of the same data may no longer agree. For example, a changed student address may be reflected in the Music department records but not elsewhere in the system.

17.3.2 Difficulty in accessing data

Suppose that one of the university clerks needs to find out the names of all students who live within a particular postal-code area. The clerk asks the data-processing department to generate such a list. Because the designers of the original system did not anticipate this request, there is no application program on hand to meet it. There is, however, an application program to generate the list of all students.

The university clerk has now two choices either obtain the list of all students and extract the needed information manually or ask a programmer to write the necessary application program. Both alternatives are obviously unsatisfactory. Suppose that such a program is written, and that, several days later, the same clerkneeds to trim that list to include only those students who have taken at least 60 credit hours. As expected, a program to generate such a list does not exist. Again, the clerk has the preceding two options, neither of which is satisfactory. The point here is that conventional file-processing environments do not allow needed data to be retrieved in a convenient and efficient manner. More responsive data-retrieval systems are required for general use.

17.3.3 Data isolation

Because data are scattered in various files, and files may be in different formats, writing new application programs to retrieve the appropriate data is difficult.

17.3.4 Integrity problems

The data values stored in the database must satisfy certain types of consistency constraints. Suppose the university maintains an account for each department, and records the balance amount in each account. Suppose also that the university requires that the account balance of a department may never fall below zero. Developers enforce these constraints in the system by adding appropriate code in the various application programs. However, when new constraints are added, it is difficult to change the programs to enforce them. The problem is compounded when constraints involve several data items from different files.

17.3.5 Atomicity problems

A computer system, like any other device, is subject to failure. In many applications, it is crucial that, if a failure occurs, the data be restored to the consistent state that existed prior to the failure.

Consider a program to transfer $500 from the account balance of department A to the account balance of department B. If a system failure occurs during the execution of the program, it is possible that the $500 was removed from the balance of department A but was not credited to the balance of department B, resulting in an inconsistent database state. Clearly, it is essential to database consistency that either both the credit and debit occur, or that neither occur.

That is, the funds transfer must be atomic—it must happen in its entirety or not at all. It is difficult to ensure atomicity in a conventional file-processing system.

17.3.6 Concurrent-access anomalies

For the sake of overall performance of the system and faster response, many systems allow multiple users to update the data simultaneously. Indeed, today, the largest Internet retailers may have millions of accesses per day to their data by shoppers. In such an environment, interaction of concurrent updates is possible and may result in inconsistent data. Consider department A, with an account balance of $10,000. If two department clerks debit the account balance (by say $500 and $100, respectively) of department A at almost exactly the same time, the result of the concurrent executions may leave the budget in an incorrect (or inconsistent) state. Suppose that the programs executing on behalf of each withdrawal read the old balance, reduce that value by the amount being withdrawn, and write the result back. If the two programs run concurrently, they may both read the value $10,000, and write back $9500 and $9900, respectively. Depending on which one writes the value last, the account balance of department A may contain either $9500 or $9900, rather than the correct value of $9400. To guard against this possibility, the system must maintain some form of supervision.

But supervision is difficult to provide because data may be accessed by many different application programs that have not been coordinated previously.

As another example, suppose a registration program maintains a count of students registered for a course, in order to enforce limits on the number of students registered. When a student registers, the program reads the current count for the courses, verifies that the count is not already at the limit, adds one to the count, and stores the count back in the database. Suppose two students register concurrently, with the count at (say) 39. The two program executions may both read the value 39, and both would then write back 40, leading to an incorrect increase of only 1, even though two students successfully registered for the course and the count should be 41. Furthermore, suppose the course registration limit was 40; in the above case both students would be able to register, leading to a violation of the limit of 40 students.

17.3.7 Security problems

Not every user of the database system should be able to access all the data. For example, in a university, payroll personnel need to see only that part of the database that has financial information. They do not need access to information about academic records. But, since application programs are added to the file-processing system in an ad hoc manner, enforcing such security constraints is difficult.

These difficulties, among others, prompted the development of database systems. In what follows, the concepts and algorithms that enable database systems to solve the problems with file-processing systems.

17.4 Advantages of DBMS

17.4.1 Controlling of Redundancy

Data redundancy refers to the duplication of data (i.e storing same data multiple times). In a database system, by having a centralized database and centralized control of data by the DBA the unnecessary duplication of data is avoided. It also eliminates the extra time for processing the large volume of data. It results in saving the storage space

Improved Data Sharing: DBMS allows a user to share the data in any number of application programs.

17.4.2 Data Integrity

Integrity means that the data in the database is accurate. Centralized control of the data helps in permitting the administrator to define integrity constraints to the data in the database. For example: in customer database we can enforce an integrity that it must accept the customer only from Noida and Meerut city.

17.4.3 Security

Having complete authority over the operational data, enables the DBA in ensuring that the only mean of access to the database is through proper channels. The DBA can define authorization checks to be carried out whenever access to sensitive data is attempted.

17.4.4 Data Consistency

By eliminating data redundancy, we greatly reduce the opportunities for inconsistency. For example: is a customer address is stored only once, we cannot have disagreement on the stored values. Also updating data values is greatly simplified when each value is stored in one place only. Finally, we avoid the wasted storage that results from redundant data storage.

17.4.5 Efficient Data Access

In a database system, the data is managed by the DBMS and all access to the data is through the DBMS providing a key to effective data processing

17.4.6 Enforcements of Standards

With the centralized of data, DBA can establish and enforce the data standards which may include the naming conventions, data quality standards etc.

17.4.7 Data Independence

Ina database system, the database management system provides the interface between the application programs and the data. When changes are made to the data representation, the meta data obtained by the DBMS is changed but the DBMS is continues to provide the data to application program in the previously used way. The DBMs handles the task of transformation of data wherever necessary.

17.4.8Reduced Application Development and Maintenance Time

DBMS supports many important functions that are common to many applications, accessing data stored in the DBMS, which facilitates the quick development of application.

17.5 Disadvantages of DBMS

1) It is bit complex. Since it supports multiple functionality to give the user the best, the underlying software has become complex. The designers and developers should have thorough knowledge about the software to get the most out of it.

2) Because of its complexity and functionality, it uses large amount of memory. It also needs large memory to run efficiently.

3) DBMS system works on the centralized system, i.e.; all the users from all over the world access this database. Hence any failure of the DBMS, will impact all the users.

4) DBMS is generalized software, i.e.; it is written work on the entire systems rather specific one. Hence some of the application will run slow.

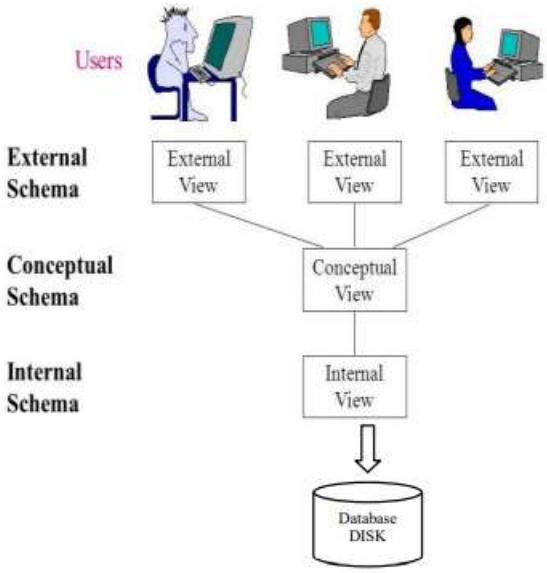
17.6 View of Data

A database system is a collection of interrelated data and a set of programs that allow users to access and modify these data. A major purpose of a database system is to provide users with an abstract view of the data.

That is, the system hides certain details of how the data are stored and maintained.

17.6.1 Data Abstraction

For the system to be usable, it must retrieve data efficiently. The need for efficiency has led designers to use complex data structures to represent data in the database. Since many database-system users are not computer trained, developers hide the complexity from users through several levels of abstraction, to simplify users' interactions with the system



17.6.2 Physical level (or Internal View / Schema)

The lowest level of abstraction describes how the data are actually stored. The physical level describes complex low-level data structures in detail.

17.6.3 Logical level (or Conceptual View / Schema)

The next-higher level of abstraction describes what data arestored in the database, and what relationships exist among those data. The logical level thus describes the entire database in terms of a small number of relatively simple structures. Although implementation of the simple structures at the logical level may involve complex physical-level structures, the user

of the logical level does not need to be aware of this complexity. This is referred to as physical data independence. Database administrators, who must decide what information to keep in the database, use the logical level of abstraction.

17.6.4 View level (or External View / Schema)

The highest level of abstraction describes only part of the entiredatabase. Even though the logical level uses simpler structures, complexity remains because of the variety of information stored in a large database. Many users of the database system do not need all this information; instead, they need to access only a part of the database. The view level of abstraction exists to simplify their interaction with the system. The system may provide many views for the same database.

An analogy to the concept of data types in programming languages may clarify the distinction among levels of abstraction. Many high-level programming languages support the notion of a structured type. For example, we may describe a record as follows:

type instructor = record

This code defines a new record type called instructor with four fields. Each field has a name and a type associated with it. A university organization may have several such record types, including

This code defines a new record type called instructor with four fields. Each field has a name and a type associated with it. A university organization may have several such record types, including Physical level (or Internal View / Schema): The lowest level of abstraction describes how the data are actually stored. The physical level describes complex low-level data structures in detail.

We can define a data dictionary as a DBMS component that stores the definition of data characteristics and relationships. You may recall that such “data about data” were labeled metadata. The DBMS data dictionary provides the DBMS with its self describing characteristic. In effect, the data dictionary resembles and X-ray of the company’s entire data set, and is a crucial element in the data administration function.

The two main types of data dictionary exist, integrated and stand alone. An integrated data dictionary is included with the DBMS. For example, all relational DBMSs include a built in data dictionary or system catalog that is frequently accessed and updated by the RDBMS. Other DBMSs especially older types, do not have a built in data dictionary instead the DBA may use third party stand alone data dictionary systems.

Data dictionaries can also be classified as active or passive. An active data dictionary is automatically updated by the DBMS with every database access, thereby keeping its access information up-to-date. A passive datadictionary is not updated automatically and usually requires a batch process to be run. Data dictionary access information is normally used by the DBMS for query optimization purpose.

The data dictionary’s main function is to store the description of all objects that interact with the database.

Integrated data dictionaries tend to limit their metadata to the data managed by the DBMS. Stand alonedata dictionary systems are more usually more flexible and allow the DBA to describe and manage all the organization’s data, whether or not they are computerized. Whatever the data dictionary’s format, its existence provides database

designers and end users with a much improved ability to communicate. In addition, the data dictionary is the tool that helps the DBA to resolve data conflicts. Although, there is no standard format for the information stored in the data dictionary several features are common. For example, the data dictionary typically stores descriptions of all:

Data elements that are define in all tables of all databases. Specifically the data dictionary stores the name, datatypes, display formats, internal storage formats, and validation rules. The data dictionary tells where an element is used, by whom it is used and so on.

Tables define in all databases. For example, the data dictionary is likely to store the name of the table creator, the date of creation access authorizations, the number of columns, and so on.

Indexes define for each database tables. For each index the DBMS stores at least the index name the attributes used, the location, specific index characteristics and the creation date.

Define databases: who created each database, the date of creation where the database is located, who the DBA is and so on.

17.7 End users and The Administrators of the data base

Programs that access the database including screen formats, report formats application formats, SQL queries and so on.

Access authorization for all users of all databases.

Relationships among data elements which elements are involved: whether the relationship are mandatory or optional, the connectivity and cardinality and so on.

17.8 Database Administrators and Database Users

A primary goal of a database system is to retrieve information from and store new information in the database.

People who work with a database can be categorized as database users or database administrators.

17.9 Database Users and User Interfaces

There are four different types of database-system users, differentiated by the way they expect to interact with the system. Different types of user interfaces have been designed for the different types of users. Naive users are unsophisticated users who interact with the system by invoking one of the application programs that have been written previously. For example, a bank teller who needs to transfer $50 from account

A to account B invokes a program called transfer. This program asks the teller for the amount of money to be transferred, the account from which the money is to be transferred, and the account to which the money is to be transferred.As another example, consider a user who wishes to find her account balance over the World Wide Web. Such a user may access a form, where she enters her account number. An application program at the Web server then retrieves the account balance, using the given account number, and passes this information back to the user.

The typical user interface for naive users is a forms interface, where the user can fill in appropriate fields of the form. Naive users may also simply read reports generated from the database.

Application programmers are computer professionals who write application programs. Application programmers can choose from many tools to develop user interfaces. Rapid application development (RAD) tools are tools that enable an application programmer to construct forms and reports without writing a program. There are also special types of programming languages that combine imperative control structures (for example, for loops, while loops and if-then-else statements) with statements of the data manipulation language. These languages, sometimes called fourth-generation languages, often include special features to facilitate the generation of forms and the display of data on the screen. Most major commercial database systems include a fourth generation language.

Sophisticated users interact with the system without writing programs. Instead, they form their requests in a database query language. They submit each such query to a query processor, whose function is to break down DML statements into instructions that the storage manager understands. Analysts who submit queries to explore data in the database fall in this category.

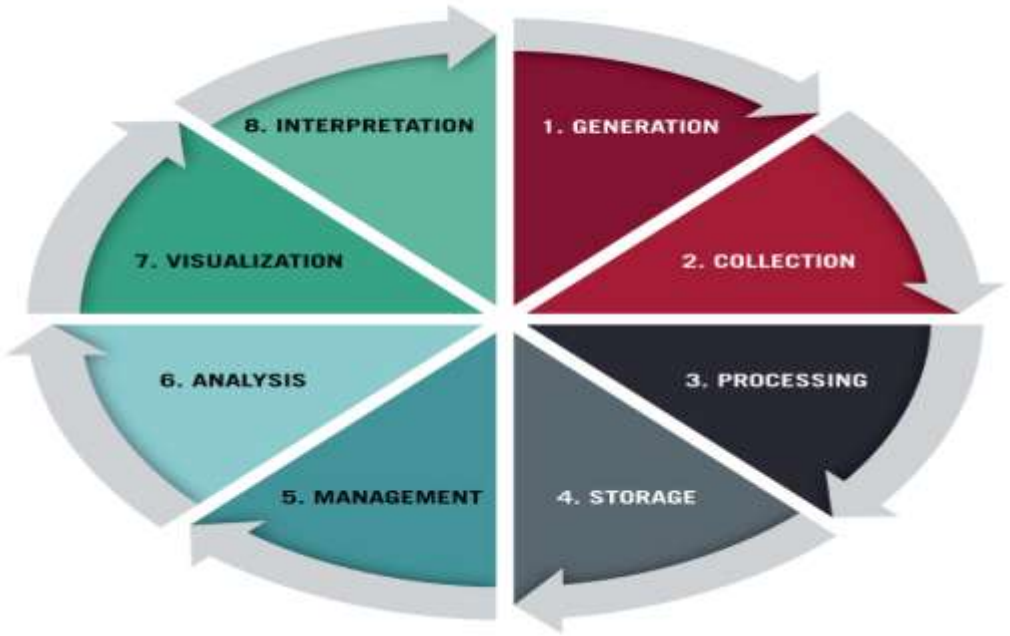
Online analytical processing (OLAP) tools simplify analysts' tasks by letting them view summaries of data in different ways. For instance, an analyst can see total sales by region (for example, North, South, East, and West), or by product, or by a combination of region and product (that is, total sales of each product in each region). The tools also permit the analyst to select specific regions, look at data in more detail (for example, sales by city within a region) or look at the data in less detail (for example, aggregate products together by category).

Another class of tools for analysts is data mining tools, which help them find certain kinds of patterns in data. Specialized users are sophisticated users who write specialized database applications that do not fit into the traditional data-processing framework.

Among these applications are computer-aided design systems, knowledge base and expert systems, systems that store data with complex data types (for example, graphics data and audio data), and environment-modeling systems.

17.10 Data Life Cycle Stages

The data life cycle is often described as a cycle because the lessons learned and insights gleaned from one data project typically inform the next. In this way, the final step of the process feeds back into the first.



17.10.1. Generation

For the data life cycle to begin, data must first be generated. Otherwise, the following steps can't be initiated.Data generation occurs regardless of whether you're aware of it, especially in our increasingly online world. Some of this data is generated by your organization, some by your customers, and some by third parties you may or may not be aware of. Every sale, purchase, hire, communication, interaction—everything generates data. Given the proper attention, this data can often lead to powerful insights that allow you to better serve your customers and become more effective in your role.

17.10.2. Collection

Not all of the data that's generated every day is collected or used. It's up to your data team to identify what information should be captured and the best means for doing so, and what data is unnecessary or irrelevant to the project at hand.

It can collect data in a variety of ways, including:

Forms: Web forms, client or customer intake forms, vendor forms, and human resources applications are some of the most common ways businesses generate data.

Surveys: Surveys can be an effective way to gather vast amounts of information from a large number of respondents.

Interviews: Interviews and focus groups conducted with customers, users, or job applicants offer opportunities to gather qualitative and subjective data that may be difficult to capture through other means.

Direct Observation: Observing how a customer interacts with your website, application, or product can be an effective way to gather data that may not be offered through the methods above.

It's important to note that many organizations take a broad approach to data collection, capturing as much data as possible from each interaction and storing it for potential use. While drawing from this supply is certainly an option, it's always important to start by creating a plan to capture the data you know is critical to your project.

17.10.3. Processing

Once data has been collected, it must be processed. Data processing can refer to various activities, including:

Data wrangling, in which a data set is cleaned and transformed from its raw form into something more accessible and usable. This is also known as data cleaning, data munging, or data remediation.

Data compression, in which data is transformed into a format that can be more efficiently stored.

Data encryption, in which data is translated into another form of code to protect it from privacy concerns.Even the simple act of taking a printed form and digitizing it can be considered a form of data processing.

17.10.4. Storage

After data has been collected and processed, it must be stored for future use. This is most commonly achieved through the creation of databases or datasets. These datasets may then be stored in the cloud, on servers, or using another form of physical storage like a hard drive, CD, cassette, or floppy disk.

When determining how to best store data for your organization, it's important to build in a certain level of redundancy to ensure that a copy of your data will be protected and accessible, even if the original source becomes corrupted or compromised.

17.10.5. Management

Data management, also called database management, involves organizing, storing, and retrieving data as necessary over the life of a data project. While referred to here as a "step," it's an ongoing process that takes place from the beginning through the end of a project. Data management includes everything from storage and encryption to implementing access logs and changelogs that track who has accessed data and what changes they may have made.

17.10.6. Analysis

Data analysis refers to processes that attempt to glean meaningful insights from raw data. Analysts and data scientists use different tools and strategies to conduct these analyses. Some of the more commonly used methods include statistical modeling, algorithms, artificial intelligence, data mining, and machine learning.

Exactly who performs an analysis depends on the specific challenge being addressed, as well as the size of your organization's data team. Business analysts, data analysts, and data scientists can all play a role.

17.10.7. Visualization

Data visualization refers to the process of creating graphical representations of your information, typically through the use of one or more visualization tools. Visualizing data makes it easier to quickly communicate your analysis to a wider audience both inside and outside your organization. The form your visualization takes depends on the data you're working with, as well as the story you want to communicate.

While technically not a required step for all data projects, data visualization has become an increasingly important part of the data life cycle.

17.10.8. Interpretation

Finally, the interpretation phase of the data life cycle provides the opportunity to make sense of your analysis and visualization. Beyond simply presenting the data, this is when you investigate it through the lens of your expertise and understanding. Your interpretation may not only include a description or explanation of what the data shows but, more importantly, what the implications may be.

17.11 Summary

The DBMS manages the data; the database engine allows data to be accessed, locked and modified; and the database schema defines the database's logical structure. These three foundational elements help provide concurrency, security, data integrity and uniform data administration procedures. The DBMS supports many typical database administration tasks, including change management, performance monitoring and tuning, security, and backup and recovery. Most database management systems are also responsible for automated rollbacks and restarts as well as logging and auditing of activity in databases and the applications that access them.The DBMS provides a centralized view of data that can be accessed by multiple users from multiple locations in a controlled manner. A DBMS can limit what data end users see and how they view the data, providing many views of a single database schema. End users and software programs are free from having to understand where the data is physically located or on what type of storage medium it resides because the DBMS handles all requests.

17.12 Key words

Rapid application development (RAD) tools are tools that enable an application programmer to construct forms and reports without writing a program.

A database-management system (DBMS) is a collection of interrelated data and a set of programs to access those data. This is a collection of related data with an implicit meaning and hence is a database

Data Consistency - By eliminating data redundancy, we greatly reduce the opportunities for inconsistency. For example: is a customer address is stored only once, we cannot have disagreement on the stored values

Data Abstraction -For the system to be usable, it must retrieve data efficiently. The need for efficiency has led designers to use complex data structures to represent data in the database.

17.13 Self Assessment Questions

1. Briefly Discuss the Uses of Data Base System in Banking and Industry

2. Explain the Advantages and Disadvantages of DBMS

3. Describe the Data lifecyle Stages

4. Outline the Users in DBMS

17.14 Suggested Readings

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6. Richard D. Johnson Kevin D. Carlson Michael J. Kavanagh (2020) Human Resource Information Systems Basics, Applications, and Future Directions, Sage Publications
7. BadgiSatish(2020)Practical Guide to Human Resource Information SystemsPHI Learning Eastern Economy Edition
8. Nicolas A. Valcik, Meghna Sabharwal, Teodoro J. Benavides (2021) Human Resources Information Systems A Guide for Public Administrators, Springer Publications.

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LESSON -18

DATABASE DESIGN

Learning Objectives

- ✓ To study the Attributes
- ✓ To Understand the Types of Database Models
- ✓ To Know the Other database models
- ✓ To discuss the Database on web

Structure

18.1 Introduction

Conceptual Database Design - Entity Relationship(ER) Modeling:

Database Design Techniques

1. ER Modeling (Top down Approach)

2. Normalization (Bottom Up approach)

18.2 Entity instance

Entity instance is a particular member of the entity type.

Example for entity instance : A particular employee

18.3 Regular Entity

An entity which has its own key attribute is a regular entity.

Example for regular entity : Employee.

18.4 Weak entity

An entity which depends on other entity for its existence and doesn't have any key attribute of its own is a weakentity.

Example for a weak entity : In a parent/child relationship, a parent is considered as a strong entity and the child is a weak entity. In ER modeling, notation for weak entity is given below

18.5 Attributes

Attributes Properties/characteristics which describe entities are called attributes. In ER modeling, notation for attribute is given below.

18.5.1 Domain of Attributes

The set of possible values that an attribute can take is called the domain of the attribute. For example, the attribute day may take any value from the set {Monday, Tuesday ... Friday}. Hence this set can be termed as the domain of the attribute day.

18.5.2 Key attribute

The attribute (or combination of attributes) which is unique for every entity instance is called key attribute.

E.g the employee_id of an employee, pan_card_number of a person etc. If the key attribute consists of two or more attributes in combination, it is called a composite key.

In ER modeling, notation for key attribute is given below.

18.5.3 Simple attribute

If an attribute cannot be divided into simpler components, it is a simple attribute.

Example for simple attribute :employee_id of an employee.

18.5.4 Composite attribute

If an attribute can be split into components, it is called a composite attribute.

Example for composite attribute : Name of the employee which can be split into First_name, Middle_name, and Last_name.

18.5.5 Single valued Attributes

If an attribute can take only a single value for each entity instance, it is a single valued attribute.

For example for single valued attribute : age of a student. It can take only one value for a particular student.

18.5.6 Multi-valued Attributes

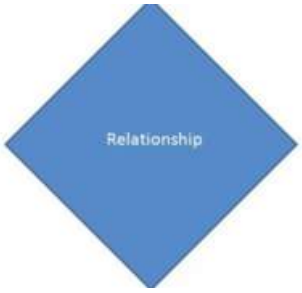
If an attribute can take more than one value for each entity instance, it is a multi-valued attribute. Multi-valued example for multi valued attribute : telephone number of an employee, a particular employee may have multiple telephone numbers.

In ER modeling, notation for multi-valued attribute is given below

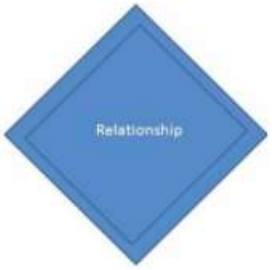
18.5.7 Stored Attribute

An attribute which need to be stored permanently is a stored attribute Example for stored attribute : name of a student Derived Attribute An attribute which can be calculated or derived based on other attributes is a derived attribute. Example for derived attribute : age of employee which can be calculated from date of birth and current date. In ER modeling, notation for derived attribute is given below.

Relationships Associations between entities are called relationships Example : An employee works for an organization. Here "works for" is a relation between the entities employee and organization. In ER modeling, notation for relationship is given below.



However in ER Modeling, To connect a weak Entity with others, you should use a weak relationship notation as given below



18.5.8 Degree of a Relationship

Degree of a relationship is the number of entity types involved. The n-ary relationship is the general form for degree n. Special cases are unary, binary, and ternary ,where the degree is 1, 2, and 3, respectively.

Example for unary relationship : An employee ia a manager of another employee

Example for binary relationship : An employee works-for department.

Example for ternary relationship : customer purchase item from a shop keeper

18.5.9 Cardinality of a Relationship

Relationship cardinalities specify how many of each entity type is allowed. Relationships can have four possible connectivities as given below.

1. One to one (1:1) relationship

2. One to many (1:N) relationship

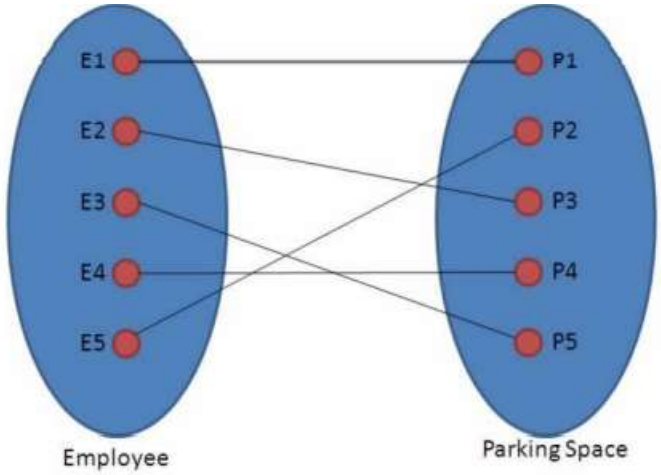
3. Many to one (M:1) relationship

4. Many to many (M:N) relationship

The minimum and maximum values of this connectivity is called the cardinality of the relationship

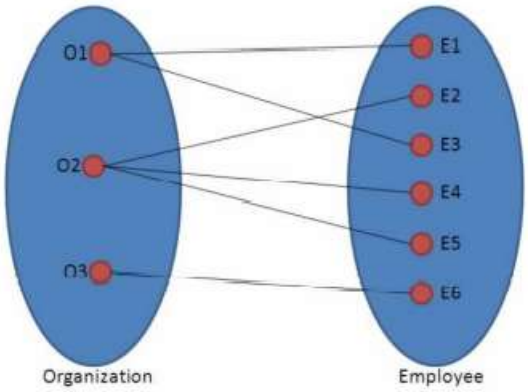
Example for Cardinality – One-to-One (1:1)

Employee is assigned with a parking space



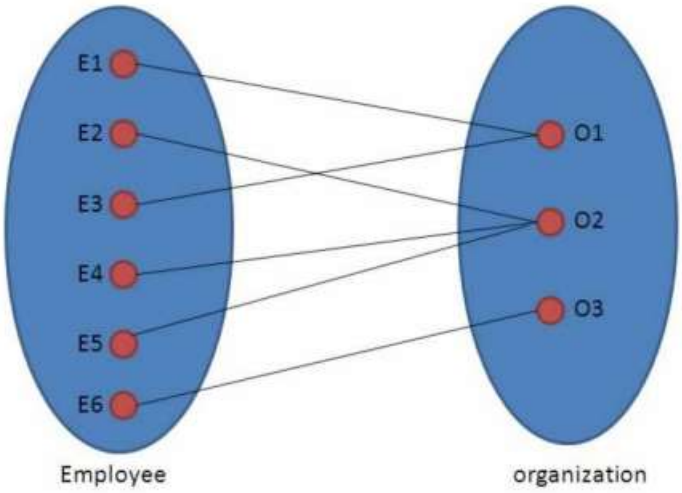
One employee is assigned with only one parking space and one parking space is assigned to only one employee. Hence it is a 1:1 relationship and cardinality is One-To-One (1:1) In ER modeling, this can be mentioned using notations as given below

Example for Cardinality – One-to-Many (1:N) Organization has employees



One organization can have many employees , but one employee works in only one organization. Hence it is a 1:N relationship and cardinality is One-To-Many (1:N) In ER modeling, this can be mentioned using notations as given below

Example for Cardinality – Many-to-One (M :1) It is the reverse of the One to Many relationship. employee works in organization



One employee works in only one organization But one organization can have many employees. Hence it is a M:1 relationship and cardinality is Many-to-One (M :1) 23 In ER modeling, this can be mentioned using notations as given below

18.6 Relationship Participation

1. Total

In total participation, every entity instance will be connected through the relationship to another instance of the

other participating entity types

2. Partial

Example for relationship participation

Consider the relationship - Employee is head of the department.

Here all employees will not be the head of the department. Only one employee will be the head of the department. In other words, only few instances of employee entity participate in the above relationship. So employee entity's participation is partial in the said relationship.

However each department will be headed by some employee. So department entity's participation is total in the said relationship

Advantages and Disadvantages of ER Modeling (Merits and Demerits of ER Modeling)

Advantages

1. ER Modeling is simple and easily understandable. It is represented in business users language and it can be understood by non-technical specialist.

2. Intuitive and helps in Physical Database creation.

3. Can be generalized and specialized based on needs.

4. Can help in database design.

5. Gives a higher level description of the system.

Disadvantages

1. Physical design derived from E-R Model may have some amount of ambiguities or inconsistency.

2. Sometime diagrams may lead to misinterpretations

18.7 Types of database models

There are many kinds of data models. Some of the most common ones include:

Hierarchical database model

Relational model

Network model

Object-oriented database model

Entity-relationship model

Document model

Entity-attribute-value model

Star schema

The object-relational model, which combines the two that make up its name

The biggest factor is whether the database management system you are using supports a particular model. Most database management systems are built with a particular data model in mind and require their users to adopt that model, although some do support multiple models. In addition, different models apply to different stages of the database design process. High-level conceptual data models are best for mapping out relationships between data in ways that people perceive that data. Record-based logical models, on the other hand, more closely reflect ways that the data is stored on the server.

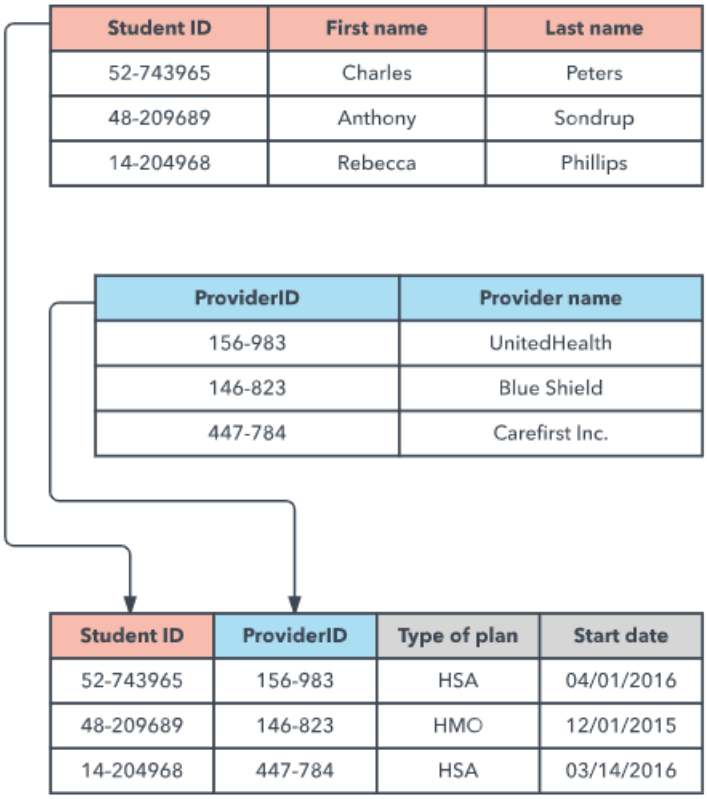
Selecting a data model is also a matter of aligning your priorities for the database with the strengths of a particular model, whether those priorities include speed, cost reduction, usability, or something else.

18.7.1 Relational model

The most common model, the relational model sorts data into tables, also known as relations, each of which consists of columns and rows. Each column lists an attribute of the entity in question, such as price, zip code, or birth date. Together, the attributes in a relation are called a domain. A particular attribute or combination of attributes is chosen as a primary key that can be referred to in other tables, when it's called a foreign key.

Each row, also called a tuple, includes data about a specific instance of the entity in question, such as a particular employee.

The model also accounts for the types of relationships between those tables, including one-to-one, one-to-many, and many-to-many relationships. Here's an example



Student ID	First name	Last name
52-743965	Charles	Peters
48-209689	Anthony	Sondrup
14-204968	Rebecca	Phillips

ProviderID	Provider name
156-983	UnitedHealth
146-823	Blue Shield
447-784	Carefirst Inc.

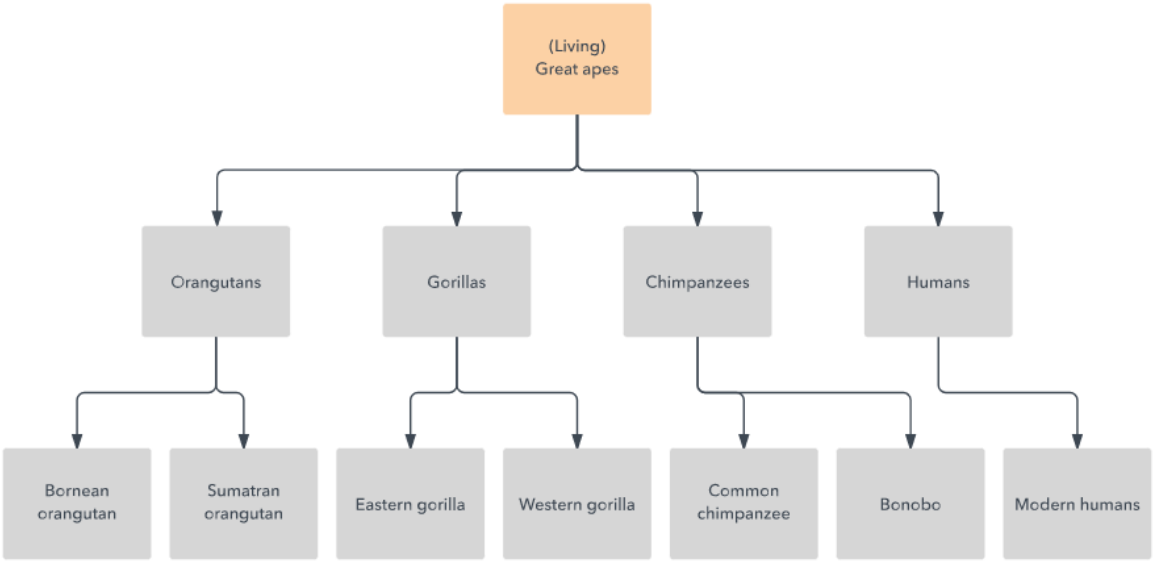
Student ID	ProviderID	Type of plan	Start date
52-743965	156-983	HSA	04/01/2016
48-209689	146-823	HMO	12/01/2015
14-204968	447-784	HSA	03/14/2016

Within the database, tables can be normalized, or brought to comply with normalization rules that make the database flexible, adaptable, and scalable. When normalized, each piece of data is atomic, or broken into the smallest useful pieces.

Relational databases are typically written in Structured Query Language (SQL). The model was introduced by E.F. Codd in 1970.

18.7.2 Hierarchical model

The hierarchical model organizes data into a tree-like structure, where each record has a single parent or root. Sibling records are sorted in a particular order. That order is used as the physical order for storing the database. This model is good for describing many real-world relationships.

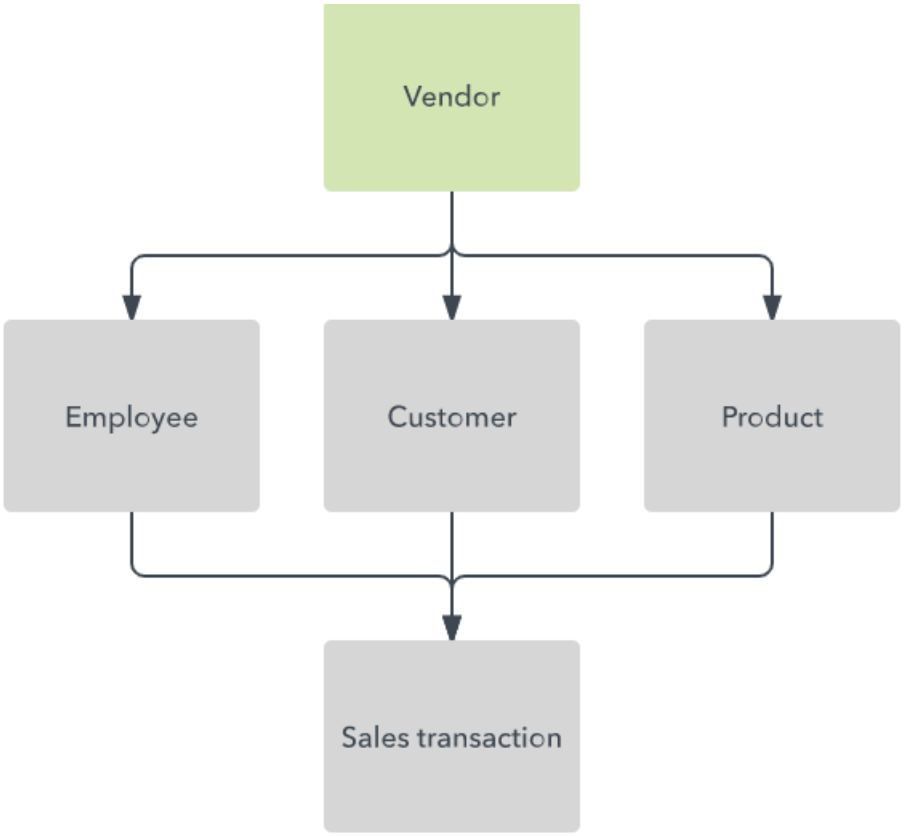


This model was primarily used by IBM's Information Management Systems in the 60s and 70s, but they are rarely seen today due to certain operational inefficiencies.

18.7.3 Network model

The network model builds on the hierarchical model by allowing many-to-many relationships between linked records, implying multiple parent records. Based on mathematical set theory, the model is constructed with sets of related records. Each set consists of one owner or parent record and one or more member or child records. A record can be a member or child in multiple sets, allowing this model to convey complex relationships.

It was most popular in the 70s after it was formally defined by the Conference on Data Systems Languages (CODASYL).



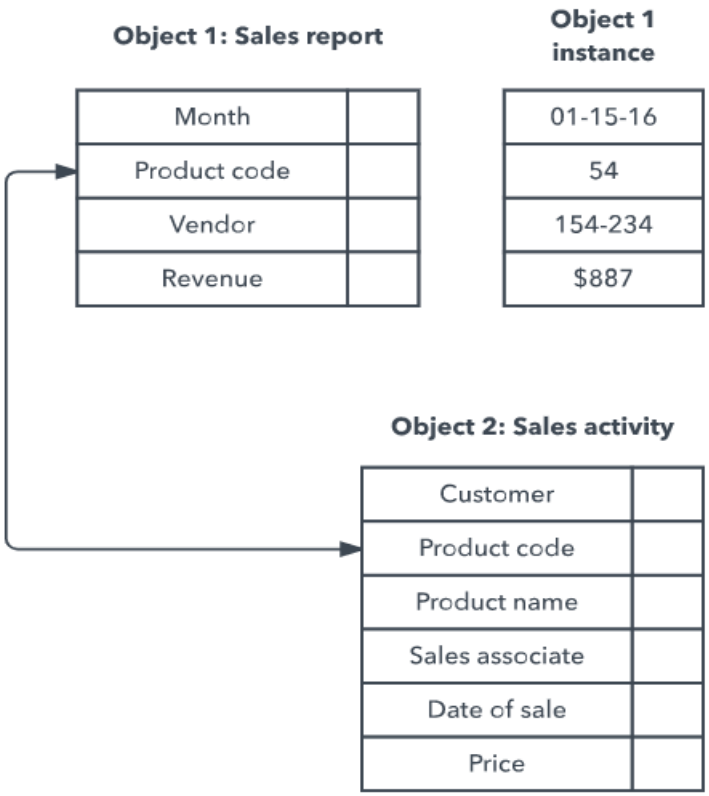
18.7.4 Object-oriented database model

This model defines a database as a collection of objects, or reusable software elements, with associated features and methods. There are several kinds of object-oriented databases:

A **multimedia database** incorporates media, such as images, that could not be stored in a relational database.

A **hypertext database** allows any object to link to any other object. It's useful for organizing lots of disparate data, but it's not ideal for numerical analysis.

The object-oriented database model is the best known post-relational database model, since it incorporates tables, but isn't limited to tables. Such models are also known as hybrid database models.



18.7.5 Object-relational model

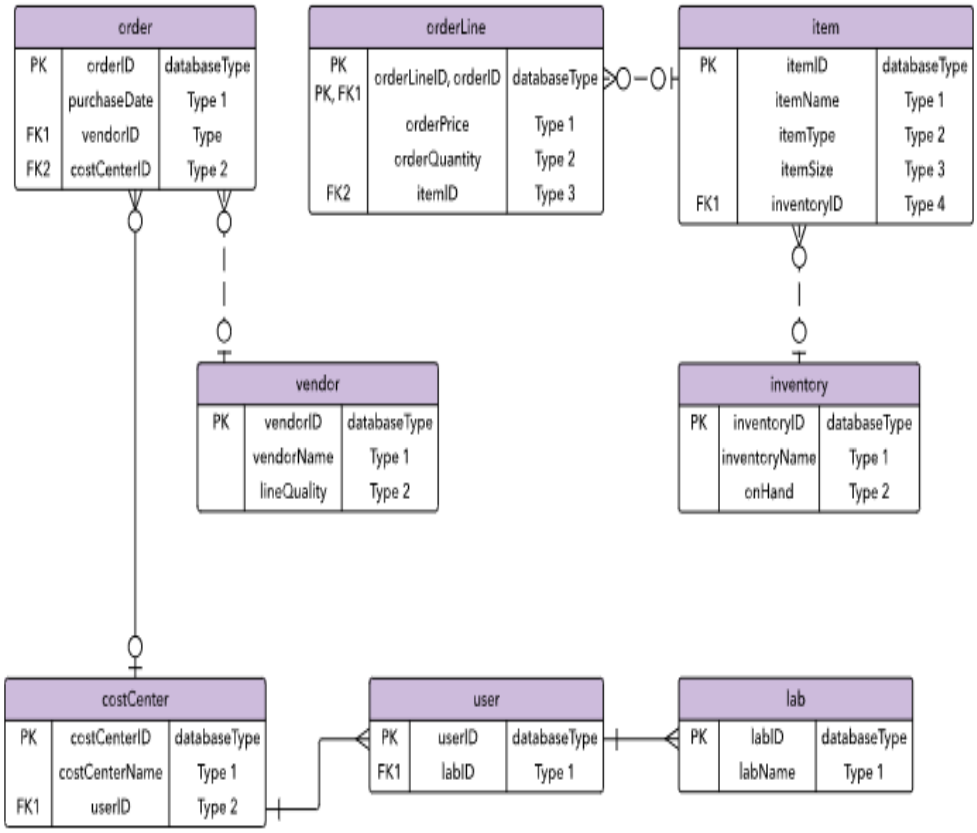
This hybrid database model combines the simplicity of the relational model with some of the advanced functionality of the object-oriented database model. In essence, it allows designers to incorporate objects into the familiar table structure.

Languages and call interfaces include SQL3, vendor languages, ODBC, JDBC, and proprietary call interfaces that are extensions of the languages and interfaces used by the relational model.

18.7.6 Entity-relationship model

This model captures the relationships between real-world entities much like the network model, but it isn't as directly tied to the physical structure of the database. Instead, it's often used for designing a database conceptually.

Here, the people, places, and things about which data points are stored are referred to as entities, each of which has certain attributes that together make up their domain. The cardinality, or relationships between entities, are mapped as well.



A common form of the ER diagram is the star schema, in which a central fact table connects to multiple dimensional tables.

18.8 Other database models

A variety of other database models have been or are still used today.

18.8.1 Inverted file model

A database built with the inverted file structure is designed to facilitate fast full text searches. In this model, data content is indexed as a series of keys in a lookup table, with the values pointing to the location of the associated files. This structure can provide nearly instantaneous reporting in big data and analytics, for instance.

This model has been used by the ADABAS database management system of Software AG since 1970, and it is still supported today.

18.8.2 Flat model

The flat model is the earliest, simplest data model. It simply lists all the data in a single table, consisting of columns and rows. In order to access or manipulate the data, the computer has to read the entire flat file into memory, which makes this model inefficient for all but the smallest data sets.

18.8.3 Multidimensional model

This is a variation of the relational model designed to facilitate improved analytical processing. While the relational model is optimized for online transaction processing (OLTP), this model is designed for online analytical processing (OLAP).

Each cell in a dimensional database contains data about the dimensions tracked by the database. Visually, it's like a collection of cubes, rather than two-dimensional tables.

18.8.4 Semistructured model

In this model, the structural data usually contained in the database schema is embedded with the data itself. Here the distinction between data and schema is vague at best. This model is useful for describing systems, such as certain Web-based data sources, which we treat as databases but cannot constrain with a schema. It's also useful for describing interactions between databases that don't adhere to the same schema.

18.8.5 Context model

This model can incorporate elements from other database models as needed. It cobbles together elements from object-oriented, semistructured, and network models.

18.8.6 Associative model

This model divides all the data points based on whether they describe an entity or an association. In this model, an entity is anything that exists independently, whereas an association is something that only exists in relation to something else.

The associative model structures the data into two sets:

A set of items, each with a unique identifier, a name, and a type

A set of links, each with a unique identifier and the unique identifiers of a source, verb, and target. The stored fact has to do with the source, and each of the three identifiers may refer either to a link or an item.

Other, less common database models include:

Semantic model, which includes information about how the stored data relates to the real world

XML database, which allows data to be specified and even stored in XML format

Named graph

Triplestore

18.8.7 NoSQL database models

In addition to the object database model, other non-SQL models have emerged in contrast to the relational model:

The graph database model, which is even more flexible than a network model, allowing any node to connect with any other.

The multivalue model, which breaks from the relational model by allowing attributes to contain a list of data rather than a single data point.

The document model,which is designed for storing and managing documents or semi-structured data, rather than atomic data.

18.9 Databases on the Web

Most websites rely on some kind of database to organize and present data to users. Whenever someone uses the search functions on these sites, their search terms are converted into queries for a database server to process. Typically, middleware connects the web server with the database.

The broad presence of databases allows them to be used in almost any field, from online shopping to micro-targeting a voter segment as part of a political campaign. Various industries have developed their own norms for database design, from air transport to vehicle manufacturing.

18.10 Summary

Database management system is a software which is used to manage the database. For example: MySQL, Oracle, etc are a very popular commercial database which is used in different applications. DBMS provides an interface to perform various operations like database creation, storing data in it, updating data, creating a table in the database and a lot more. It provides protection and security to the database. In the case of multiple users, it also maintains data consistency.

18.11 Key words

Entity instance- Entity instance is a particular member of the entity type

Regular Entity- An entity which has its own key attribute is a regular entity

Weak entity- An entity which depends on other entity for its existence and doesn't have any key attribute of its own is a weak entity.

Attributes- Attributes Properties/characteristics which describe entities are called attributes. In ER modeling, notation for attribute

Key attribute- The attribute (or combination of attributes) which is unique for every entity instance is called key attribute.

Stored Attribute- An attribute which need to be stored permanently is a stored attribute Example for stored attribute : name of a student Derived Attribute

18.11Self Assessment Questions

1. Briefly explain the different Types of Attributes
2. Examine the types of Database Models
3. Outline the Other Database Models
4. Discuss the Database on the Web.

18.13 Suggested Readings

1. James A. O'Brien & George M. Marakas(2011) Management Information Systems Tenth Edition Mc.GrawHilll IRWIN.
2. Hossein Bidgoli, NilanjanChattopadhyay(2016) Management information system Edition by Cengage India
3. Gupta, Ashok Kumar (2018) Developing Human Resource Information System by, Daya

Publishing House
4. Mohan Thite(2019) e-HRM: Digital Approaches, Directions & Applications Routledge Publications,
5. Talya Bauer, Berrin Erdogan, David E. Caughlin, and Donald M. Truxillo (2019) Human Resource Management: People, Data, and Analytics Sage Publications Incorporation
6. Richard D. Johnson Kevin D. Carlson Michael J. Kavanagh (2020) Human Resource Information Systems Basics, Applications, and Future Directions, Sage Publications
7. BadgiSatish(2020)MPractical Guide to Human Resource Information SystemsPHI Learning Eastern Economy Edition
8. Nicolas A. Valcik, Meghna Sabharwal, Teodoro J. Benavides (2021) Human Resources Information Systems A Guide for Public Administrators, Springer Publications.

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LESSON -19

DATABASE LANGUAGES

Learning Objectives

- ✓ To study the DBMS
- ✓ To learn the Functions of DBMS
- ✓ To Know the Advantages of DBMS
- ✓ To Outline the Disadvantages of DBMS
- ✓ To focus on the Data Base Users
- ✓ To Identify the Elements of DBMS

Structure

19.0 Introduction

Hence a database approach emerged. A database is a persistent collection of logically related data. The initial attempts were to provide a centralized collection of data. A database has a self describing nature. It contains not only the data sharing and integration of data of an organization in a single database.

A small database can be handled manually but for a large database and having multiple users it is difficult to maintain it, In that case a computerized database is useful.

The advantages of database system over traditional, paper based methods of recordkeeping are:

Compactness: No need for large amount of paper files

speed: The machine can retrieve and modify the data more faster way then human being

Less drudgery: Much of the maintenance of files by hand is eliminated

Accuracy: Accurate, up-to-date information is fetched as per requirement of the user at any time.

19.1 Database Management System (DBMS)

A database management system consists of collection of related data and refers to a set of programs for defining, creation, maintenance and manipulation of a database.

19.2 Function of DBMS

1. Defining database schema: it must give facility for defining the database structure also specifies access rights to authorized users.

2. Manipulation of the database: The DBMS must have functions like insertion of record into database updation of data, deletion of data, retrieval of data

3. Sharing of database: The DBMS must share data items for multiple users by maintaining consistency of data.

4. Protection of database: It must protect the database against unauthorized users.

5. Database recovery: If for any reason the system fails DBMS must facilitate database recovery.

19.3 Advantages of DBMS

19.3.1 Reduction of redundancies

Centralized control of data by the DBA avoids unnecessary duplication of data and effectively reduces the total amount of data storage required avoiding duplication in the limitation of the inconsistencies that tend to be present in redundant data files.

19.3.2 Sharing of data

A database allows the sharing of data under its control by any number of application programs or users.

19.3.3 Data Integrity

Data integrity means that the data contained in the database is both accurate and consistent. Therefore data values being entered for storage could be checked to ensure that they fall within a specified range and are of the correct format.

19.3.4 Data Security

The DBA who has the ultimate responsibility for the data in the DBMS can ensure that proper access procedures are followed including proper authentication schemas for access to the DBS and additional check before permitting access to sensitive data.

19.3.5 Conflict resolution

DBA resolve the conflict on requirements of various user and applications. The DBA chooses the best file structure and access method to get optional performance for the application.

19.3.6 Data Independence

Data independence is usually considered from two points of views; physically data independence and logical data independence.

Physical data Independence allows changes in the physical storage devices or organization of the files to be made without requiring changes in the conceptual view or many of the external views and hence in the application programs using the data base.

Logical data independence indicates that the conceptual schema can be changed without affecting the existing external schema or any application program.

19.4 Disadvantage of DBMS

1. DBMS software and hardware (networking installation) cost is high

2. The processing overhead by the DBMS for implementation of security, integrity and sharing of the data.

3. Centralized database control

4. Setup of the database system requires more knowledge, money, skills, and time.

5. The complexity of the database may result in poor performance.

19.5 Database Basics

19.5.1 Data item

The data item is also called as field in data processing and is the smallest unit of data that has meaning to its users.

Eg: “e101”,”sumit”

Entities and attributes:

An entity is a thing or object in the real world that is distinguishable from all other objects

Eg: Bank, employee, student

Attributes are properties are properties of an entity.

Eg: Emp code, e name, rol no, name

Logical data and physical data :Logical data are the data for the table created by user in primary memory.

Physical data refers to the data stored in the secondary memory.

19.5.2 Schema and sub-schema

A schema is a logical data base description and is drawn as a chart of the types of data that are used . It gives the names of the entities and attributes and specify the relationships between them.

A database schema includes such information as :

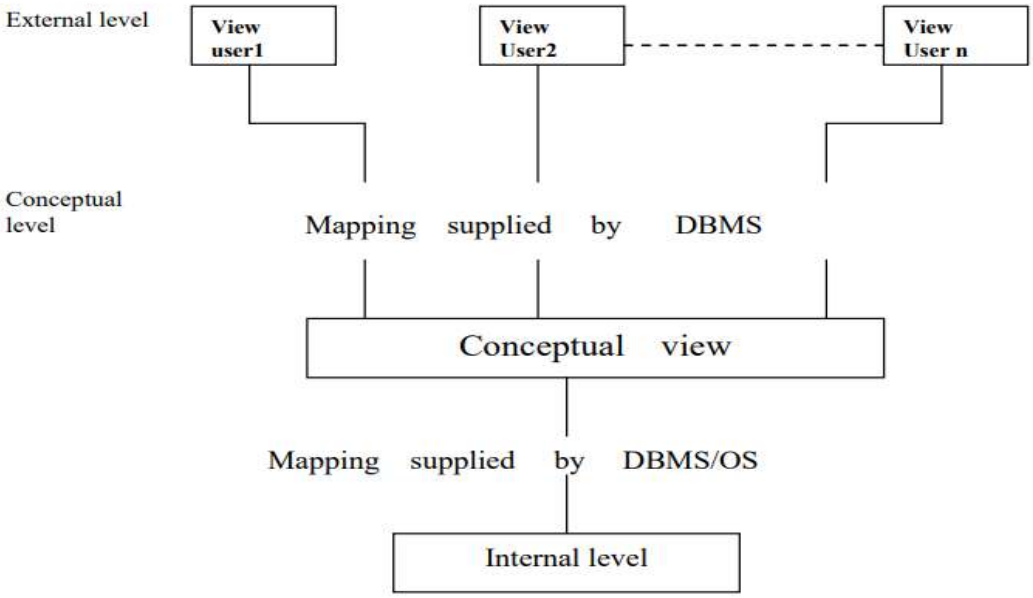
Characteristics of data items such as entities and attributes .

Logical structures and relationships among these data items .

19.5.3 Format for storage representation.

Integrity parameters such as physical authorization and back up policies. A subschema is derived schema derived from existing schema as per the user requirement. There may be more than one subschema create for a single conceptual schema.

Three level architecture of DBMS :



A database management system that provides three level of data is said to follow three level architecture.

External level

Conceptual level

Internal level

19.6 Levels of Data Base Architecture

19.6.1 External level

The external level is at the highest level of database abstraction. At this level, there will be many views define for different users requirement. A view will describe only a subset of the database. Any number of user views may exist for a given global or subschema. For example , each student has different view of the time table. the view of a student of B.Tech (CSE) is different from the view of the student of B.Tech (ECE).Thus this level of abstraction is concerned with different categories of users.

Each external view is described by means of a schema called schema or schema.

19.6.2 Conceptual level

At this level of database abstraction all the database entities and the relationships among them are included . One conceptual view represents the entire database. This conceptual view is defined by the conceptual schema. The conceptual schema hides the details of physical storage structures and concentrate on describing entities, data types, relationships, user operations and constraints.

It describes all the records and relationships included in the conceptual view. There is only one conceptual schema per database . It includes feature that specify the checks to relation data consistency and integrity.

19.6.3 Internal level

It is the lowest level of abstraction closest to the physical storage method used .It indicates how the data will be stored and describes the data structures and access methods to be used by the database . The internal view is expressed by internal schema.

The following aspects are considered at this level:

1. Storage allocation e.g: B-tree, hashing

2. access paths eg. specification of primary and secondary keys, indexes etc.,

3. Miscellaneous eg. Data compression and encryption techniques, optimization of the internal structures.

19.7 Database Users

19.7.1 Naive users

Users who need not be aware of the presence of the database system or any other system supporting their usage are considered naïve users . A user of an automatic teller machine falls on this category

19.7.2 Online users

These are users who may communicate with the database directly via an online terminal or indirectly via a user interface and application program. These users area ware of the database system and also know the data manipulation language system.

19.7.3 Application programmers

Professional programmers who are responsible for developing application programs or user interfaces utilized by the naïve and online user falls into this category.

19.7.4 Database Administration

A person who has central control over the system is called database administrator .

The function of DBA are :

1. Creation and modification of conceptual Schema definition

2. Implementation of storage structure and access method.

3. Schema and physical organization modifications .

4. Granting of authorization for data access.

5. Integrity constraints specification.

6. Execute immediate recovery procedure in case of failures

7. Ensure physical security to database

19.8 Database language

19.8.1 Data definition language(DDL)

DDL is used to define database objects .The conceptual schema is specified by a set of definitions expressed by this language. It also give some details about how to implement this schema in the physical devices used to store the data. This definition includes all the entity sets and their associated attributes and their relationships. The result of DDL statements will be a set of tables that are stored in special file called data dictionary.

19.8.2 Data manipulation language (DML)

A DML is a language that enables users to access or manipulate data stored in the database. Data manipulation involves retrieval of data from the database, Insertion of new data into the database and deletion of data or modification of existing data.

There are basically two types of DML:

procedural: Which requires a user to specify what data is needed and how to get it.

non- procedural: which requires a user to specify what data is needed with out specifying how to get it.

19.8.3 Data control language(DCL)

This language enables user to grant authorization and canceling authorization of database objects.

19.9 Elements of DBMS

19.9.1 DML pre-compiler

It converts DML statement embedded in an application program to normal procedure calls in the host language. The pre-complier must interact with the query processor in order to generate the appropriate code.

19.9.2 DDL compiler

The DDL compiler converts the data definition statements into a set of tables. These tables contains information concerning the database and are in a form that can be used by other components of the DBMS.

19.9.3 File manager

File manager manages the allocation of space on disk storage and the data structure used to represent information stored on disk.

19.9.4 Database manager

A database manager is a program module which provides the interface between the low level data stored in the database and the application programs and queries submitted to the system.

19.10The responsibilities of database manager are

19.10.1 Interaction with file manager

The data is stored on the disk using the files system which is provided by operating system. The database manager translate the different DML statements into low-level file system commands. so The database manager is responsible for the actual storing, retrieving and updating of data in the database.

19.10.2Integrity enforcement

The data values stored in the database must satisfy certain constraints (eg: the age of a person can't be less then zero).These constraints are specified by DBA. Data manager checks the constraints and fit satisfies then it stores the data in the database.

19.10.3Security enforcement

Data manager checks the security measures for database from unauthorized users.

19.10.4 Backup and recovery

Database manager detects the failures occurs due to different causes (like disk failure, power failure, dead lock, s/w error) and restores the database to original state of the database.

19.10.5Concurrency control

When several users access the same database files simultaneously, there may be possibilities of data inconsistency. It is responsible of database manager to control the problems occurs for concurrent transactions.

19.10.6 Query processor

The query processor used to interpret to online user's query and convert it into an efficient series of operations in a form capable of being sent to the data manager for

19.10.7 Execution

The query processor uses the data dictionary to find the details of data file and using this information it create query plan/access plan to execute the query.

19.11 Data Dictionary

Data dictionary is the table which contains the information about database objects. It contains information like

1. external, conceptual and internal database description

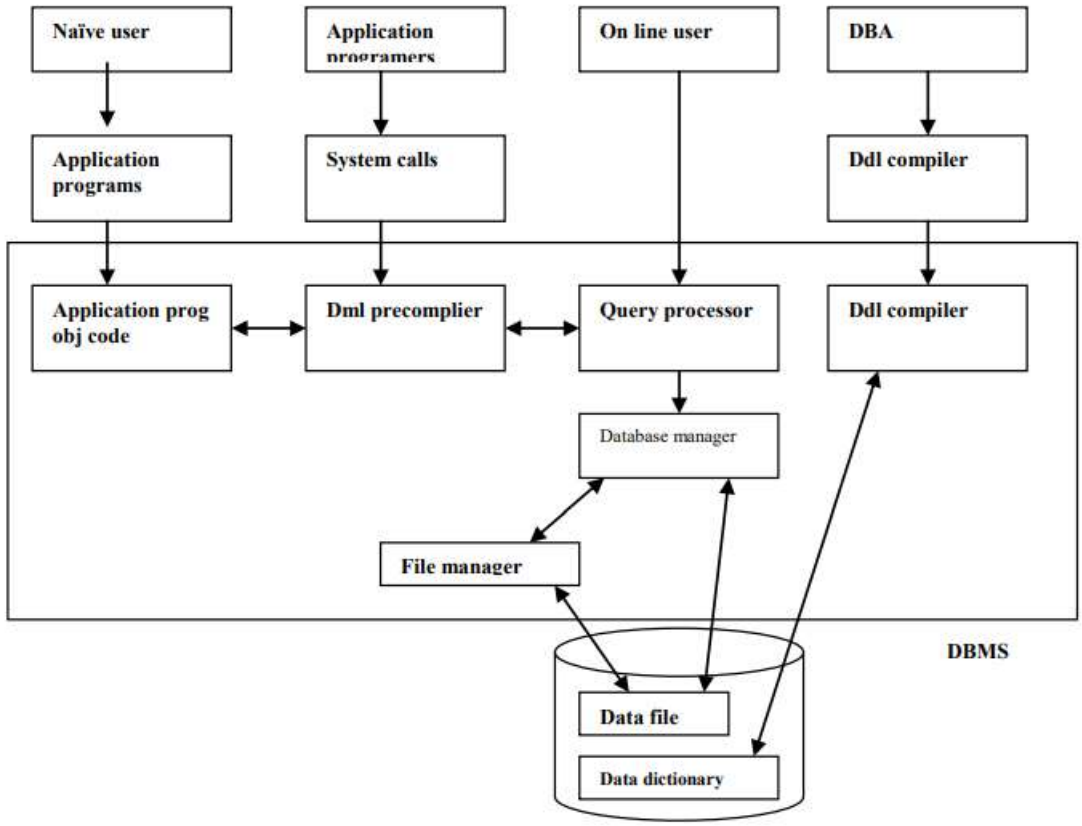
2. description of entities , attributes as well as meaning of data elements

3. synonyms, authorization and security codes

4. database authorization

The data stored in the data dictionary is called meta data.

DBMS structure



19.12 Data Base Language

Database languages, also known as query languages or data query languages, are a classification of programming languages that developers use to define and access databases, which are collections of organized data that users can access electronically. These languages allow users to complete tasks such as controlling access to data, defining and updating data and searching for information within the database management system (DBMS). A DBMS is a piece of technology that interacts with users, applications and the database to record and analyze data while also manipulating the database to offer a way to store, access and retrieve data.

A DBMS provides necessary database languages that allow users to express database updates and queries, which are requests for data. There are different examples of database languages available, including SQL, which is the standard programming language for many databases. Database languages comprise four sublanguages that serve different functions to execute tasks.

4 categories of database languages

Here are four types of database languages and their uses:

19.12.1 Data definition language (DDL)

Data definition language (DDL) creates the framework of the database by specifying the database schema, which is the structure that represents the organization of data. Its common uses include the creation and alteration of tables, files, indexes and columns within the database. This language also allows users to rename or drop the existing database or its components. Here's a list of DDL statements:

CREATE: Creates a new database or object, such as a table, index or column

ALTER: Changes the structure of the database or object

DROP: Deletes the database or existing objects

RENAME: Renames the database or existing objects

19.12.2. Data manipulation language (DML)

Data manipulation language (DML) provides operations that handle user requests, offering a way to access and manipulate the data that users store within a database. Its common functions include inserting, updating and retrieving data from the database. Here's a list of DML statements:

INSERT: Adds new data to the existing database table

UPDATE: Changes or updates values in the table

DELETE: Removes records or rows from the table

SELECT: Retrieves data from the table or multiple tables

19.12.3 Data control language (DCL)

Data control language (DCL) controls access to the data that users store within a database. Essentially, this language controls the rights and permissions of the database system. It allows users to grant or revoke privileges to the database. Here's a list of DCL statements:

GRANT: Gives a user access to the database

REVOKE: Removes a user's access to the database

19.12.4 Transaction control language (TCL)

Transaction control language (TCL) manages the transactions within a database. Transactions group a set of related tasks into a single, executable task. All the tasks must succeed in order for the transaction to work. Here's a list of TCL statements:

COMMIT: Carries out a transaction

ROLLBACK: Restores a transaction if any tasks fail to execute

S**AVEPOINT**: Sets a point in a transaction to save.

Examples of database languages

Here are six examples of database languages and how to use them:

19.13 SQL

SQL, which stands for Structured Query Language, is one of the most well-known and longest-running database languages. It features both data definition and data manipulation languages and allows you to write queries in a database. Specifically, SQL provides a way for you to extract and manage data in a relational database management system. This type of DBMS organizes data into groups called relations. Because most relational databases use SQL as the database language, many jobs in the IT industry may require their employees to have an understanding of it.

19.14 XQuery

XQuery is a database language that allows you to extract and manipulate data in XML formats, which is a way to share data on the internet. You can use XQuery to access and retrieve any data source in an XML format. With XQuery, you can generate reports on data within an XML database, search text documents on the web for data and extract data for use online.

19.15 OQL

OQL, which stands for Object Query Language, is the standard language for object-oriented databases, which represent data as variables, functions or data structures. These databases are popular with companies that want to store large amounts of complex data. Much like SQL does in relational databases, OQL gives you the option to perform queries and retrieve data in object databases.

19.16 SQL/XML

The SQL/XML language is a combination of SQL and XQuery that supports the manipulation and storage of XML data in a database that works with SQL. It enables applications to perform SQL statements on XML data and vice versa. It's helpful when you

want to extract content from an XML document or if you want to ensure compatibility with future optimizations or systems that may only support XML.

19.17 Graph QL

Graph QL is an open-source language that works with APIs, which are interfaces that allow users to interact with data. It provides a way to define the structure of data and how the system returns information in order to prevent the release of excessive amounts of data. It's helpful when you want to extract data from multiple APIs, aggregate data from different sources or specify the data efficiently.

19.18 LINQ

LINQ, or Language Integrated Query, is a language that extracts and processes data from XML documents, relational databases and other third-party sources. With LINQ, you can access data through various sources without having to use a separate database language for each one. This ensures consistency among queries for objects, relational databases and XML, allowing you to filter, order and group operations.

19.19 Summary

Databases serve an important function for many individuals and companies, providing a practical way to organize and store information on a computer. In programming, developers use database languages to maintain and monitor an electronic database and its management system. These languages perform a variety of critical tasks that help a database management system function correctly. In this article, we define database languages, explain the different types of languages and provide a list of some common database languages and their uses.

19.20 Key words

DBMS A database management system consists of collection of related data and refers to a set of programs for defining, creation, maintenance and manipulation of a database.

DDL is used to define database objects .The conceptual schema is specified by a set of definitions expressed by this language. It also gives one details about how to implement this schema in the physical devices used to store the data

Database languages, also known as query languages or data query languages, are a classification of programming languages that developers use to define and access databases, which are collections of organized data that users can access electronically

Data definition language (DDL) creates the framework of the database by specifying the database schema, which is the structure that represents the organization of data.

Data manipulation language (DML)- Data manipulation language (DML) provides operations that handle user requests, offering a way to access and manipulate the data that users store within a database

19.21 Self Assessment Questions

1. Briefly Discuss the DBMS

2. Explain the Functions of DBMS

3. Describe the Advantages and Disadvantages of DBMS

4. Outline the Database Users

5. Examine the Elements of DBMS

19.22 Suggested Readings

1. James A. O'Brien & George M. Marakas(2011) Management Information Systems Tenth Edition Mc. Graw Hilll IRWIN.
2. Hossein Bidgoli, Nilanjan Chattopadhyay(2016) Management information system Edition by Cengage India
3. Gupta, Ashok Kumar (2018) Developing Human Resource Information System by, Daya Publishing House
4. Mohan Thite (2019) e-HRM: Digital Approaches, Directions & Applications Routledge Publications,
5. Talya Bauer, Berrin Erdogan, David E. Caughlin, and Donald M. Truxillo (2019) Human Resource Management: People, Data, and Analytics Sage Publications Incorporation
6. Richard D. Johnson Kevin D. Carlson Michael J. Kavanagh (2020) Human Resource Information Systems Basics, Applications, and Future Directions, Sage Publications
7. BadgiSatish(2020) M Practical Guide to Human Resource Information Systems PHI Learning Eastern Economy Edition
8. Nicolas A. Valcik, Meghna Sabharwal, Teodoro J. Benavides (2021) Human Resources Information Systems A Guide for Public Administrators, Springer Publications.

Dr. V. Naga Nirmala

LESSON -20

NETWORKS

Learning objectives

- ✓ To study the Networks
- ✓ To know the Uses of Computer Networks
- ✓ To Learn the characteristics of Data Communication
- ✓ To Outline the Components of Data Communication
- ✓ To focus on the Physical Structure of Data Communication

Structure

20.1 Introduction

A network is a set of devices (often referred to as nodes) connected by communication links. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network.

"Computer network'' to mean a collection of autonomous computers interconnected by a single technology. Two computers are said to be interconnected if they are able to exchange information.

The connection need not be via a copper wire; fiber optics, microwaves, infrared, and communication satellites can also be used.

Networks come in many sizes, shapes and forms, as we will see later. They are usually connected together to make larger networks, with the Internet being the most well-known example of a network of networks.

There is considerable confusion in the literature between a computer network and a distributed system. The key distinction is that in a distributed system, a collection of independent computers appears to its users as a single coherent system. Usually, it has a single model or paradigm that it presents to the users. Often a layer of software on top of the operating system, called middleware, is responsible for implementing this model. A well-known example of a distributed system is the World Wide Web. It runs on top of the Internet and presents a model in which everything looks like a document

A network can be defined as a group of computers and other devices connected in some ways so as to be able to exchange data. -Each of the devices on the network can be thought of as a node; each node has a unique address. -Addresses are numeric quantities that are easy for computers to work with, but not for humans to remember. Example: 204.160.241.98 -Some networks also provide names that humans can more easily remember than numbers. Example: www.javasoft.com, corresponding to the above numeric address

20.2 Addressing

i. Internet address
ii. Consists of 4 bytes separated by periods Example: 136.102.233.49
iii. The R first bytes (R= 1,2,3) correspond to the network address;
iv. The remaining H bytes (H = 3,2,1) are used for the host machine.
v. Inter NIC Register: organization in charge of the allocation of the address ranges corresponding to networks.

vi. Criteria considered:
vii. Geographical area (country)
viii. Organization, enterprise
ix. Department
x. Host

20.3 Domain Name System (DNS)

Mnemonic textual addresses are provided to facilitate the manipulation of internet addresses.

DNS servers are responsible for translating mnemonic textual Internet addresses into hard numeric Internet addresses.

20.4 Ports

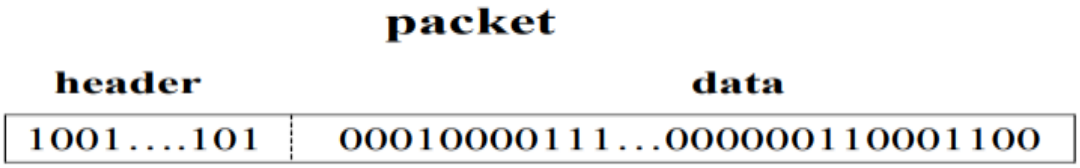
i. An IP address identifies a host machine on the Internet.
ii. An IP port will identify a specific application running on an Internet host machine.
iii. A port is identified by a number, the port number.
iv. The number of ports is not functionally limited, in contrast to serial communications where only 4 ports are allowed.
v. There are some port numbers which are dedicated for specific Applications

Applications	Port numbers
HTTP	80
FTP	20 and 21
Gopher	70
SMTP (e-mail)	25
POP3 (e-mail)	110
Telnet	23
Finger	79

20.5 Data Transmission

i. In modern networks, data are transferred using packet switching.
ii. Messages are broken into units called packets, and sent from one computer to the other.
iii. At the destination, data are extracted from one or more packets and used to reconstruct the original message.
iv. Each packet has a maximum size, and consists of a header and a data area.

v. The header contains the addresses of the source and destination computers and sequencing information necessary to reassemble the message at the destination.



20.6 Uses of Computer Networks

20.6.1 Business Applications

To distribute information throughout the company (resource sharing). Sharing physical resources such as printers, and tape backup systems, is sharing information client-server model.

It is widely used and forms the basis of much network usage communication medium among employees.

i. Email (electronic mail), which employees generally use for a great deal of daily communication.
ii. Telephone calls between employees may be carried by the computer network instead of by the phone company. This technology is called IP telephony or
iii. Voice over IP (VoIP) when Internet technology is used.
iv. Desktop sharing lets remote workers see and interact with a graphical computer screen doing business electronically, especially with customers and suppliers. This new model is called e-commerce (electronic commerce) and it has grown rapidly in recent years.

20.6.2 Home Applications

- Peer-To-Peer Communication
- Person-To-Person Communication
- Electronic Commerce
- Entertainment.(Game Playing,)

20.6.3 Mobile Users

- Text messaging or texting
- Smart phones,
- GPS (Global Positioning System)
- m-commerce
- NFC (Near Field Communication)

20.6.4 Social Issues

With the good comes the bad, as this new-found freedom brings with it many unsolved social, political, and ethical issues. Social networks, message boards, content sharing sites, and a host of other applications allow people to share their views with like-minded individuals. As long as the subjects are restricted to technical topics or hobbies like gardening, not too many problems will arise.

The trouble comes with topics that people actually care about, like politics, religion, or sex. Views that are publicly posted may be deeply offensive to some people. Worse yet, they may not be politically correct. Furthermore, opinion need not be limited to text; high-resolution color photographs and video clips are easily shared over computer networks. Some people take a live-and-let-live view, but others feel that posting certain material (e.g., verbal attacks on particular countries or religions, pornography, etc.) is simply unacceptable and that such content must be censored. Different countries have different and conflicting laws in this area. Thus, the debate rages.

Computer networks make it very easy to communicate. They also make it easy for the people who run the network to snoop on the traffic. This sets up conflicts over issues such as employee rights versus employer rights. Many people read and write email at work. Many employers have claimed the right to read and possibly censor employee messages, including messages sent from a home computer outside working hours. Not all employees agree with this, especially the latter part.

Another conflict is centered on government versus citizen's rights. A new twist with mobile devices is location privacy. As part of the process of providing service to your mobile device the network operators learn where you are at different times of day. This allows them to track your movements. They may know which nightclub you frequent and which medical center you visit.

Phishing ATTACK:

Phishing is a type of social engineering attack often used to steal user data, including login credentials and credit card numbers. It occurs when an attacker, masquerading as a trusted entity, dupes a victim into opening an email, instant message, or text message

BOTNET ATTACK:

Botnets can be used to perform distributed denial-of-service attack (DDoS attack), steal data, send spam, and allows the attacker to access the device and its connection.

The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.

20.7 Characteristics of Data Communications

20.7.1 Delivery

The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.

20.7.2 Accuracy

The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.

20.7.3 Timeliness

The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.

20.7.4 Jitter

Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packets are sent every 30 Ms. If some of the packets arrive with 30-msdelay and others with 40-ms delay, an uneven quality in the video is the result.

20.8 Components of Data Communication

20.8.1 Message

The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.

20.8.2 Sender

The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

20.8.3 Receiver

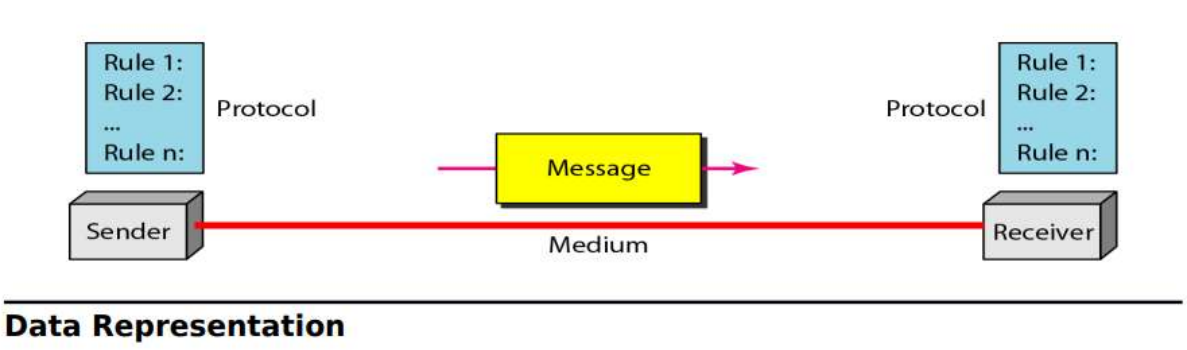
The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

20.8.4 Transmission medium

The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.

20.8.5 Protocol

A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without protocol, two devices may be connected but not communicating, just as adperson speaking French cannot be understood by a person who speaks only Japanese.



Data Representation

Data Flow Communication between two devices can be simplex, half-duplex, or full-duplex as shown in Figure.

Simplex

In simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit; the other can only receive (Figure a). Keyboards and traditional monitors are examples of simplex devices.

Half-Duplex

In half-duplex mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive, and vice versa (Figure b). Walkie-talkies and CB (citizens band) radios are both half duplex systems.

Full-Duplex

In full-duplex, both stations can transmit and receive simultaneously (Figure c).One common example of full-duplex communication is the telephone network. When two people are communicating by a telephone line, both can talk and listen at the same time. The full-duplex mode is used when communication in both directions is required all the time.

Network Criteria

A network must be able to meet a certain number of criteria. The most important of these are performance, reliability, and security. Performance can be measured in many ways, including transit time and response time. Transit time is the amount of time required for a message to travel from one device to another. Response time is the elapsed time between an inquiry and a response. The performance of a network depends on a number of factors, including the number of users, the type of transmission medium, the capabilities of the connected hardware, and the efficiency of the software. Performance is often evaluated by two networking metrics: throughput and delay. We often need more throughputs and less delay. However, these two criteria are often contradictory. If we try to send more data to the network, we may increase throughput but we increase the delay because of traffic congestion in the network. Reliability: In addition to accuracy of delivery, network reliability is measured by the frequency of failure, the time it takes a link to recover from a failure, and the network's robustness in a catastrophe. Security: Network security issues include protecting data from unauthorized access, protecting data from damage and development, and implementing policies and procedures for recovery from breaches and data losses

20.9 Physical Structures of Data communication

Before discussing networks, we need to define some network attributes.

20.9.1Type of Connection

A network is two or more devices connected through links. A link is communications pathway that transfers data from one device to another. There are two possible types of connections: point-to-point and multipoint.

20.9.2 Point-to-Point

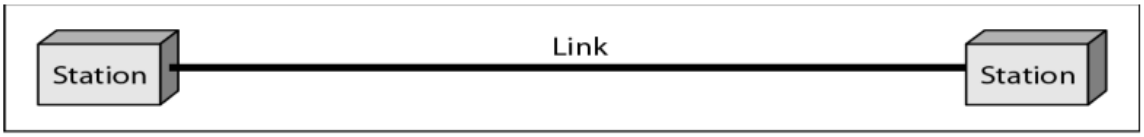
A point-to-point connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices. Most point-to-point connections use an actual length of wire or cable to connect the two ends, but other options, such as microwave or satellite links, are also possible

When you change television channels by infrared remote control, you reestablish a point-to-point connection between the remote control and the television's control system.

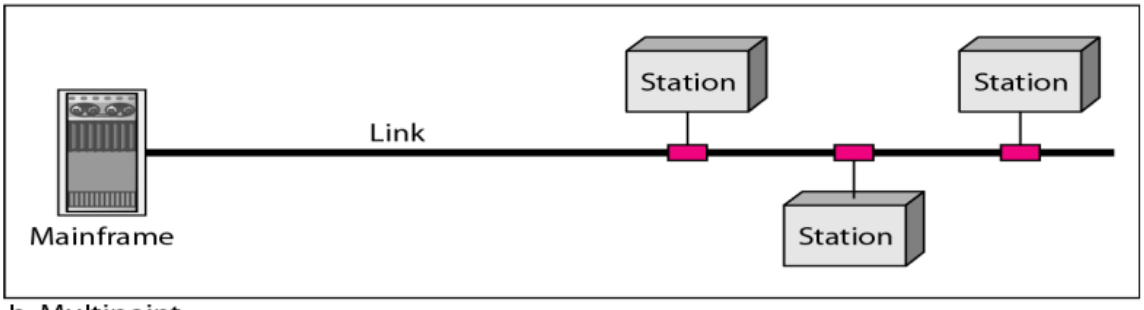
20.9.3 Multipoint

A multipoint (also called multi-drop) connection is one in which more than two specific devices share a single link

In a multipoint environment, the capacity of the channel is shared, either spatially or temporally. If several devices can use the link simultaneously, it is spatially shared connection. If users must take turns, it is a timeshared connection



a. Point-to-point

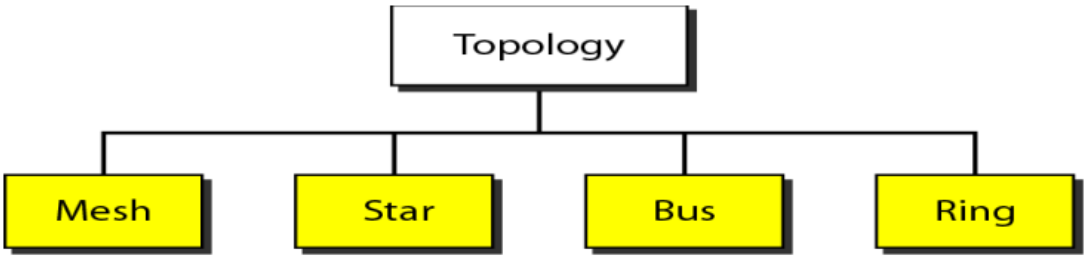


b. Multipoint

20.9.5 Physical Topology

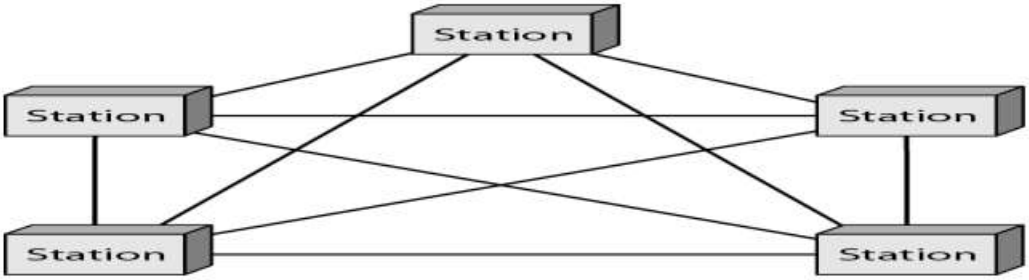
The term physical topology refers to the way in which a network is laid out physically. Two or more devices connect to a link; two or more links form a topology. The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another.

There are four basic topologies possible: mesh, star, bus, and ring



20.10 MESH

A mesh topology is the one where every node is connected to every other node in the network.



A mesh topology can be a full mesh topology or a partially connected mesh topology.

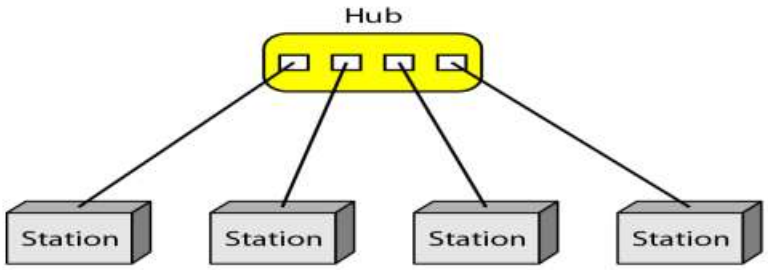
In a full mesh topology, every computer in the network has a connection to each of the other computers in that network. The number of connections in this network can be calculated using the following formula (n is the number of computers in the network): n(n-1)/2

In a partially connected mesh topology, at least two of the computers in the network have connections to multiple other computers in that network. It is an inexpensive way to implement redundancy in a network. In the event that one of the primary computers or connections in the network fails, the rest of the network continues to operate normally.

Advantages of a mesh topology

i. Can handle high amounts of traffic, because multiple devices can transmit data simultaneously.
ii. A failure of one device does not cause a break in the network or transmission of data.
iii. Adding additional devices does not disrupt data transmission between other devices.
iv. Disadvantages of a mesh topology
v. The cost to implement is higher than other network topologies, making it a less desirable option.
vi. Building and maintaining the topology is difficult and time consuming.
vii. The chance of redundant connections is high, which adds to the high costs and potential for reduced efficiency.

20.11 STAR



A star network, star topology is one of the most common network setups. In this configuration, every node connects to a central network device, like a hub, switch, or computer. The central network device acts as a server and the peripheral devices act as clients. Depending on the type of network card used in each computer of the star topology, a coaxial cable or a RJ-45 network cable is used to connect computers together.

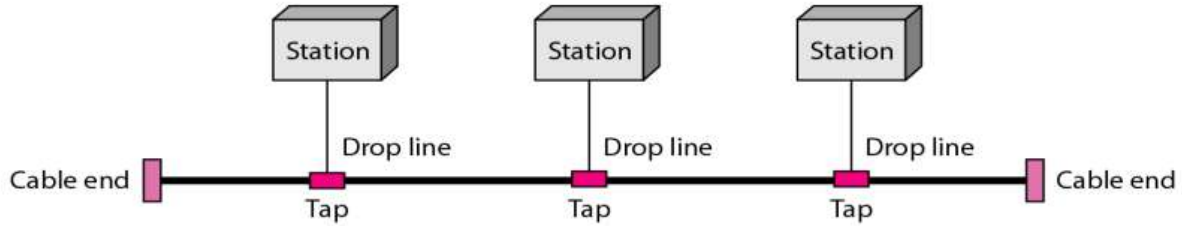
Advantages of star topology

i. Centralized management of the network, through the use of the central computer, hub, or switch.
ii. Easy to add another computer to the network.
iii. If one computer on the network fails, the rest of the network continues to function normally.
iv. The star topology is used in local-area networks (LANs), High-speed LAN soften use a star topology with a central hub.

Disadvantages of star topology

i. Can have a higher cost to implement, especially when using a switch or router as the central network device.
ii. The central network device determines the performance and number of nodes the network can handle.
iii. If the central computer, hub, or switch fails, the entire network goes down and all computers are disconnected from the network

20.12 BUS



a line topology, a bus topology is a network setup in which each computer and network device are connected to a single cable or backbone.

Advantages of bus topology

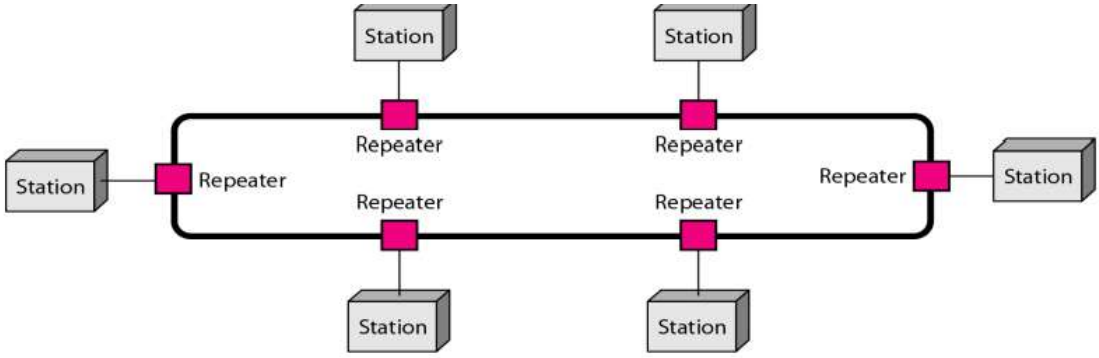
i. It works well when you have a small network.
ii. It's the easiest network topology for connecting computers or peripherals in a linear fashion.
iii. It requires less cable length than a star topology.

Disadvantages of bus topology

i. It can be difficult to identify the problems if the whole network goes down.
ii. It can be hard to troubleshoot individual device issues.
iii. Bus topology is not great for large networks.
iv. Terminators are required for both ends of the main cable.
v. Additional devices slow the network down.

If a main cable is damaged, the network fails or splits into two

20.13 RING



A ring topology is a network configuration in which device connections create a circular data path. In a ring network, packets of data travel from one device to the next until they reach their destination. Most ring topologies allow packets to travel only in one direction, called a unidirectional ring network. Others permit data to move in either direction, called bidirectional.

The major disadvantage of a ring topology is that if any individual connection in the ring is broken, the entire network is affected. Ring topologies may be used in either local area networks (LANs) or wide area networks (WANs).

Advantages of ring topology

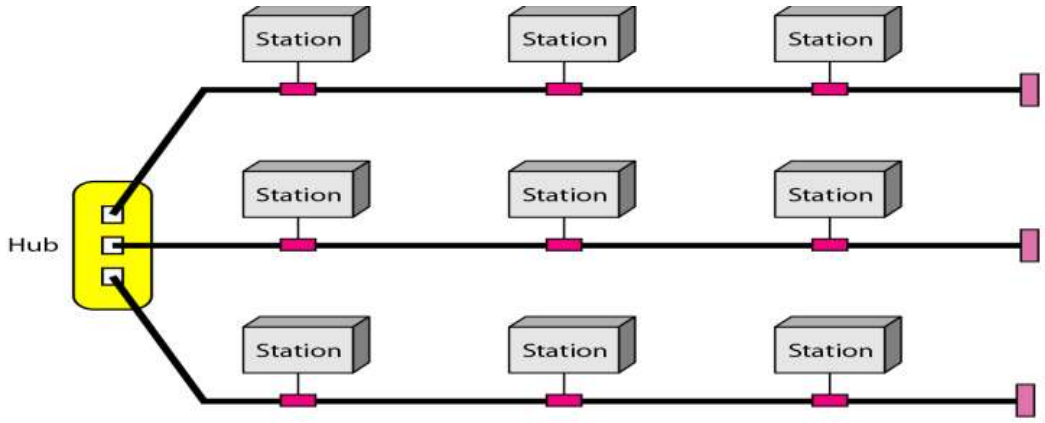
i. All data flows in one direction, reducing the chance of packet collisions.
ii. A network server is not needed to control network connectivity between each workstation.
iii. Data can transfer between workstations at high speeds.
iv. Additional workstations can be added without impacting performance of the network.

Disadvantages of ring topology

i. All data being transferred over the network must pass through each workstation on the network, which can make it slower than a star topology.
ii. The entire network will be impacted if one workstation shuts down.
iii. The hardware needed to connect each workstation to the network is more expensive than Ethernet cards and hubs/switches.

20.14 Hybrid Topology

A network can be hybrid. For example, we can have a main star topology with each branch connecting several stations in a bus topology as shown in Figure



Types of Network based on size

The types of network are classified based upon the size, the area it covers and its physical architecture. The three primary network categories are LAN, WAN and MAN. Each network differs in their characteristics such as distance, transmission speed, cables and cost.

20.15 Basic types

20.15.1 LAN (Local Area Network)

i. Group of interconnected computers within a small area. (room, building, campus)
ii. Two or more pc's can from a LAN to share files, folders, printers, other devices.
iii. Coaxial or CAT 5 cables are normally used for connections. Due to short distances, errors and noise are minimum.
iv. Data transfer rate is 10 to 100 mbps.

Example: A computer lab in a school.

20.15.2 MAN

i. (Metropolitan Area Network)Design to extend over a large area. Connecting number of LAN's to form larger network, so that resources can be shared.
ii. Networks can be up to 5 to 50 km.
iii. Owned by organization or individual.
iv. Data transfer rate is low compare to LAN.

Example: Organization with different branches located in the city.

20.15.3 WAN

i. (Wide Area Network)Are country and worldwide network.
ii. Contains multiple LAN's and MAN's.
iii. Distinguished in terms of geographical range.
iv. Uses satellites and microwave relays.
v. Data transfer rate depends upon the ISP provider and varies over the location.
vi. Best example is the internet.

Other types

WLAN (Wireless LAN)

A LAN that uses high frequency radio waves for communication. Provides short range connectivity with high speed data transmission.

PAN (Personal Area Network)

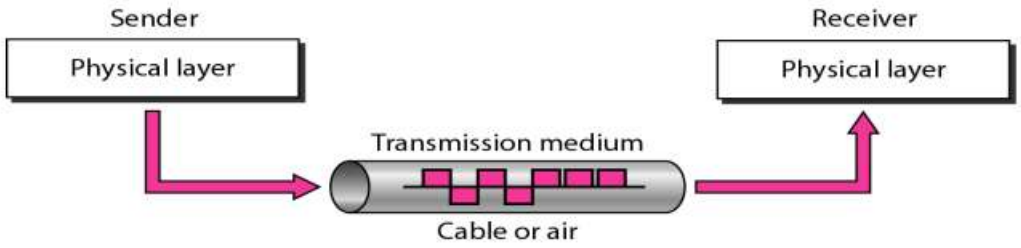
Network organized by the individual user for its personal use.

SAN (Storage Area Network)

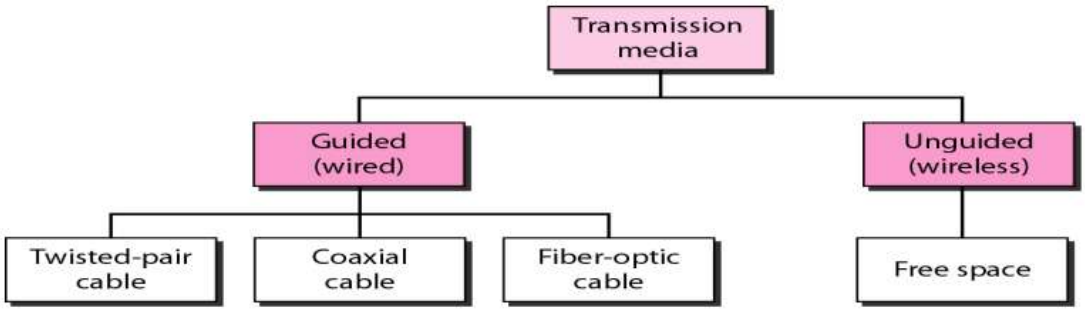
Connects servers to data storage devices via fiber-optic cables.

E.g.: Used for daily backup of organization or a mirror copy

A transmission medium can be broadly defined as anything that can carry information from a source to a destination

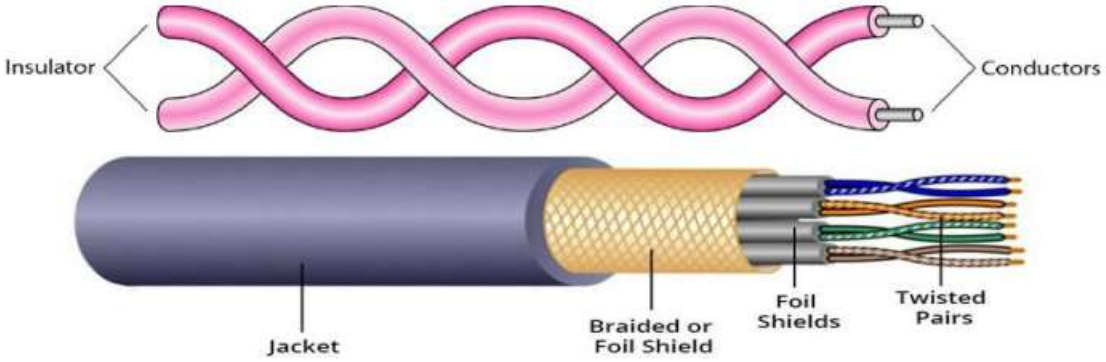


20.16 Classes of transmission media



20.16.1 Guided Media

Guided media, which are those that provide a medium from one device to another, include twisted-pair cable, coaxial cable, and fiber-optic cable. Twisted-Pair Cable: A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together. One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference.



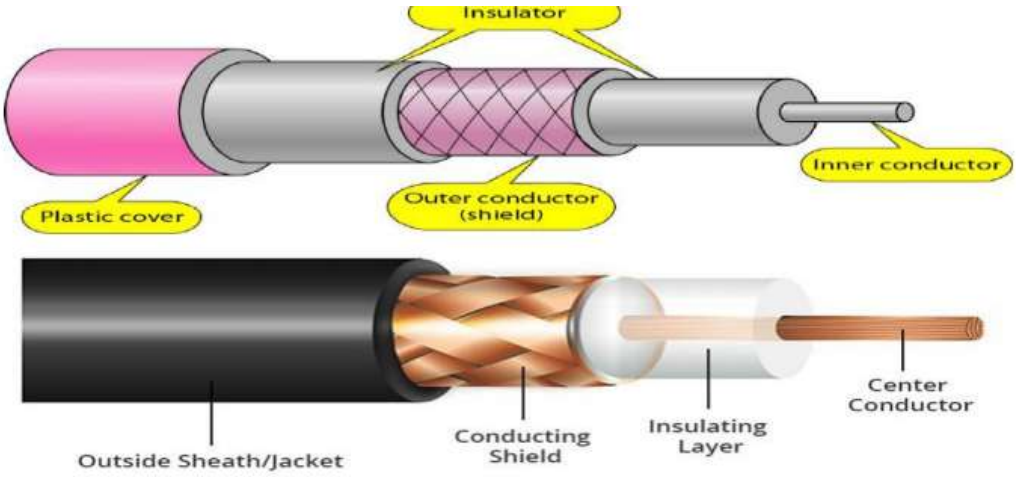
20.16.2 Unshielded Versus Shielded Twisted-Pair Cable

The most common twisted-pair cable used in communications is referred to as unshielded twisted-pair (UTP). STP cable has a metal foil or braided mesh covering that encases each pair of insulated conductors. Although metal casing improves the quality of cable by preventing the penetration of noise or crosstalk, it is bulkier and more expensive.

The most common UTP connector is RJ45 (RJ stands for registered jack) Applications Twisted-pair cables are used in telephone lines to provide voice and data channels. Local-area networks, such as l0Base-T and l00Base-T, also use twisted-pair cables.

20.16.3 Coaxial Cable Coaxial cable (or coax)

IT carries signals of higher frequency ranges than those in twisted pair cable. coax has a central core conductor of solid or stranded wire (usually copper) enclosed in an insulating sheath, which is, in turn, encased in an outer conductor of metal foil, braid, or a combination of the two. The outer metallic wrapping serves both as a shield against noise and as the second conductor, which completes the circuit. This outer conductor is also enclosed in an insulating sheath, and the whole cable is protected by a plastic cover.



The most common type of connector used today is the Bayone-Neill-Concelman(BNe), connector.

Applications

Coaxial cable was widely used in analog telephone networks, digital telephone networks

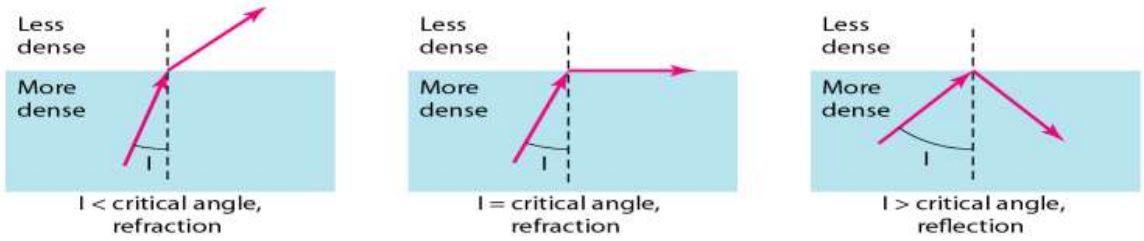
Cable TV networks also use coaxial cables.

Another common application of coaxial cable is in traditional Ethernet LANs

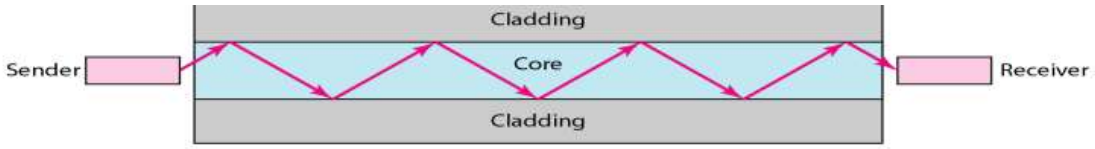
20.16.4 Fiber-Optic Cable

i. A fiber-optic cable is made of glass or plastic and transmits signals in the form of light. Light travels in a straight line as long as it is moving through a single uniform substance.
ii. If a ray of light traveling through one substance suddenly enters another substance(of a different density), the ray changes direction.

20.16.5 Bending of light ray



Optical fibers use reflection to guide light through a channel. A glass or plastic core is surrounded by a cladding of less dense glass or plastic.



20.17 Summary

Computers connected to a network are broadly categorized as servers or workstations. Servers are generally not used by humans directly, but rather run continuously to provide "services" to the other computers (and their human users) on the network. Services provided can include printing and faxing, software hosting, file storage and sharing, messaging, data storage and retrieval, complete access control (security) for the network's resources, and many others. Workstations are called such because they typically do have a human user which interacts with the network through them. Workstations were traditionally considered a desktop, consisting of a computer, keyboard, display, and mouse, or a laptop, with with integrated keyboard, display, and touchpad. With the advent of the tablet computer, and the touch screen devices such as iPad and iPhone, our definition of workstation is quickly evolving to include those devices, because of their ability to interact with the network and utilize network services**.**

20.18 Key words

Computer network'' to mean a collection of autonomous computers interconnected by a single technology

Phishing ATTACK- Phishing is a type of social engineering attack often used to steal user data, including login credentials and credit card numbers.

BOTNET ATTACK-Botnets can be used to perform distributed denial-of-service attack (DDoS attack), steal data, send spam, and allows the attacker to access the device and its connection

Jitter-Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets

Protocol- A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices.

Network Criteria -A network must be able to meet a certain number of criteria. The most important of these are performance, reliability, and security. Performance Performance can be measured in many ways, including transit time and response time

Mesh Topology-In a full mesh topology, every computer in the network has a connection to each of the other computers in that network

Star Network- A star network, star topology is one of the most common network setups. In this configuration, every node connects to a central network device, like a hub, switch, or computer

A ring topology is a network configuration in which device connections create a circular data path

20.19 Self Assessment questions

1. Briefly Discuss the Uses of Computer Networks
2. Explain the Characteristics of Data Communication
3. Discuss the Components of Data Communication
4. Outline the Physical Structure of Data Communication

20.20 Suggested Readings

1. James A. O'Brien & George M. Marakas(2011) Management Information Systems Tenth Edition Mc.GrawHilll IRWIN.
2. Hossein Bidgoli, NilanjanChattopadhyay(2016) Management information system Edition by Cengage India
3. Gupta, Ashok Kumar (2018) Developing Human Resource Information System by, Daya Publishing House
4. Mohan Thite(2019) e-HRM: Digital Approaches, Directions & Applications Routledge Publications,
5. Talya Bauer, Berrin Erdogan, David E. Caughlin, and Donald M. Truxillo (2019) Human Resource Management: People, Data, and Analytics Sage Publications Incorporation
6. Richard D. Johnson Kevin D. Carlson Michael J. Kavanagh (2020) Human Resource

Information Systems Basics, Applications, and Future Directions, Sage Publications
7. BadgiSatish(2020)Practical Guide to Human Resource Information SystemsPHI Learning Eastern Economy Edition
8. Nicolas A. Valcik, Meghna Sabharwal, Teodoro J. Benavides (2021) Human Resources Information Systems A Guide for Public Administrators, Springer Publications.

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304HM21

MODEL QUESTION PAPER
MA(HRM) DEGREE EXAMINATION
Second Year, Semester- III
Paper-IV

Time : Three Hours **Maximum: 70 marks**

SECTION A- (5x4= 20 marks)

Answer any FIVE of the following

1(a) Information system
(b) Computer
(c)CPU
(d)Configuration
(e) MIS
(f) Data Representation
(g) Binary System
(h) Database Language
(i) CPU
(j) Storage Devices

SECTION B- (2 x 10=20 marks)

Answer any TWO of the following

2) Discuss the Importance of Computer?

3) Describe the Generationof Computers?

4) Discuss the MIS Application Framework Models?

5) Elaborate the MIS in Banking and Production Unit?

SECTION B- (2 x 15=30 marks)

Answer any TWO of the following

6) Explain the Types of Data Base Management system?

7) Describe the Herbert Simons Model of Decision Making?

8) Discuss the MIS in Hotel Industry?

9) Elaborate the Process of Decision Making in data base Management system?