Management Information Systems (MIS): General Introduction

When computers were first used in the mid-1950s, the applications were primarily the simple processing of transaction records and preparation of business documents and standard reports. This was termed Data Processing (DP) or Electronic Data Processing (EDP). By the mid-1960s, many users and builders of information processing systems developed a more comprehensive vision of what computers could do for organizations. This vision was termed as Management Information System (MIS). It enlarged the scope of data processing to add systems for supporting management and administrative activities including planning, scheduling, analysis and decision making.

In the 1980s and 1990s, there was a merging of computer and communications technologies. The organizational use of information technology was extended to Intranet (internal networks), Local Area Networks (LAN), external networks that connects an organization to its suppliers and customers, and communications systems that enable employees to work alone or in groups. Innovative applications of information technology created value by providing customized services at any time and at any location, and information systems began to prompt changes in organizational structures and processes. Although the scope of systems providing information technology services has increased dramatically, the broad concept of MIS as a system that combines transaction and operational requirements with administrative and management support remains valid. The term MIS is still in common use despite a recent tendency to use the simpler term “Information Systems”.
Before one can explain management information systems, the terms *Systems, Data, Information, Knowledge, Wisdom, and Management* must briefly be defined:

A system is a combination or arrangement of parts to form an integrated whole according to some common principles or rules. A *system* is a group of interrelated components working together toward a common goal by accepting inputs and producing outputs in an organized transformation process. It is an assembly of elements arranged in a local order to achieve certain objectives. The organization is also a system of people where people are selected on the basis of number, quality and ability and are placed in hierarchical order plan and execute the business activities to achieve certain goals and objectives. Such a system (sometimes called a dynamic system) has three basic interacting components or functions:

- **Input**: involves capturing and assembling elements that enter the system to be processed. For example, raw materials, energy, data, and human efforts must be secured and organized for processing.

- **Processing**: involves transformation process that converts input into output. Examples are a manufacturing process, or mathematical calculations.

- **Output**: involves transferring elements that have been produced by a transformation process to their ultimate destination. For example, finished products, human services, and management information must be transmitted to their human users.
Feedback and Control

A system with feedback and control components is sometimes called a cybernetic system, that is, a self-monitoring, self-regulating system.

- **Feedback** is data about the performance of a system. For example, data about sales performance is feedback to a sales manager.

- **Control** involves monitoring and evaluating feedback to determine whether a system is moving toward the achievement of its goal. The control function then makes necessary adjustments to a system’s input and processing components to ensure that it produces proper output. For example, a sales manager exercises control when he or she reassigns salespersons to new sales territories after evaluating feedback about their sales performance.

**Example:** Organizations such as government agencies are good examples of the systems in society, which is their environment. Society contains a multitude of such systems, including individuals and their social, political, and economic institutions. Organizations themselves consist of many subsystems, such as departments, divisions, process teams, and other workgroups. Organizations are examples of open systems because they interface and interact with other systems in their environment. Finally, organizations are examples of adaptive systems, since they can modify themselves to meet the demands of a changing environment.
DIKW Hierarchy

DIKW refers to data, information, knowledge and wisdom; it is an information hierarchy where each layer adds certain attributes over and above the previous one. Data is the most basic level; Information adds context; Knowledge adds how to use it; and wisdom adds when to use it. This is the class of models for representing structural and functional relationships between data, information, knowledge, and wisdom, where the later is understood as ability to increase effectiveness and add value.

As such, DIKW is a model that is useful to understanding analysis and the importance and limits of conceptual works. Evaluated understanding (wisdom) is the only stage of DIKW evolution dealing with the future; this is the tool for decision making.

Data item refer to an elementary description of things, events, activities, and transactions that are recorded, classified, and stored, but not organized to convey any specific meeting. Data items can be numeric, alphanumeric, figures, sounds, or images. A student grade in a class is a data item, and so is the number of hours an employee worked in a certain week.

A single piece of data is called a datum. Unrelated items of data are considered to be essentially without meaning and are often described as ‘noise’. It is only when data have been placed in some form of context that they become meaningful to a manager.

Data can exist naturally or can be created artificially. Naturally occurring data need only to be recorded. Managers have to put in place procedures and
tools to ensure data are recorded. For example, to ensure a call centre operator includes the postcode of every customer this can be written into their script and a validation check performed to check these data have been entered into the system. Artificial data are often produced as a by-product of process. Processing an organization's accounts, for example, might produce the number of sales made in a particular month.

**Information** is data that have been organized so that they have meaning and value to the recipient. For example, a student’s grade point average is information. The recipient interprets the meaning and draws conclusions and implications from the data. Data items typically are processed into information by means of an application. Such processing represents a more specific use and a higher value-added than simple retrieval and summarization from a database. The application might be a Web-based inventory management system, a university online registration system, or an Internet-based buying and selling system.

**Creating Information**

Processing data is necessary to place them into a meaningful context so that they can be easily understood by the recipient. Figure 1 illustrates the conversion of data into information.

A number of different data processes can be used to transform data into information. Data processes are sometimes also known as “transformation processes”. The next section describes a range of common data processes.
Data processes

Some examples of data processes include the following:

♦ **Classification**: This involves placing data into categories, for example categorizing an expense as either a fixed or a variable cost.

♦ **Rearranging/sorting**: This involves organizing data so that items are grouped together or placed into a particular order. Employee data, for example, might be sorted according to surname or payroll number.

♦ **Aggregating**: This involves summarizing data, for example by calculating averages, totals or subtotals.

♦ **Performing calculations**: An example might be calculating an employee’s gross pay by multiplying the number of hours worked by the hourly rate of pay.
♦ **Selection**: This involves choosing or discarding items of data based on a set of selection criteria. A sales organization, for example, might create a list of potential customers by selecting those with incomes above a certain level.

It is worth noting that any action that serves to place data into a meaningful context can be considered a valid data process. In addition, several processes may be used in combination to produce information.

**Knowledge** consists of data and/or information that have been organized and processed to convey understanding, experience, accumulated learning, and expertise as they apply to a current problem or activity. Data that are processed to extract critical implications and to reflect past experiences and expertise provide the recipient with organizational knowledge, which has a very high potential value.

Data, information, and knowledge can be inputs to an information system, and they can also be outputs. For example, data about employees, their wages, and time worked are processed as inputs in order to produce an organization’s payroll information (output). The payroll information itself can later be used as an input to another system that prepares a budget or advises management on salary scales.

**Wisdom** is an extrapolative and non-deterministic, non-probabilistic process. It calls upon all the previous levels of consciousness, and specifically upon special types of human programming (moral, ethical codes, etc.). It beckons to give us understanding about which there has previously been no
understanding, and in doing so, goes far beyond understanding itself. It is the essence of philosophical probing. Unlike the previous levels, it asks questions to which there is no (easily-achievable) answer, and in some cases, to which there can be no humanly-known answers period. Wisdom is therefore, the process by which we also discern, or judge, between right and wrong, good and bad. Many scientists believe that computers do not have, and will never have the ability to possess' wisdom. Wisdom is a uniquely human state, requires one to have a soul, for it resides as much in the heart as in the mind.

The following diagram represents the transitions from data, to information, to knowledge, and finally to wisdom.

![Figure 2: Data, information, knowledge and wisdom Framework](image-url)
Table 1: Distinctions between data, information, knowledge and wisdom

<table>
<thead>
<tr>
<th>Level</th>
<th>Definition</th>
<th>Learning process</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Raw facts</td>
<td>Accumulating truths</td>
<td>Memorization (data bank)</td>
</tr>
<tr>
<td>Information</td>
<td>Meaningful, useful data</td>
<td>Giving form and functionality</td>
<td>Comprehension (information bank)</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Clear understanding of information</td>
<td>Analysis and synthesis</td>
<td>Understanding (knowledge bank)</td>
</tr>
<tr>
<td>Wisdom</td>
<td>Using knowledge to establish and achieve goals</td>
<td>Discerning judgments and taking appropriate action</td>
<td>Better living/success (wisdom bank)</td>
</tr>
</tbody>
</table>

*Management* is usually defined as planning, organizing, directing, staffing and controlling the organization's operations. This definition, defines what a manager does, but it is probably more appropriate to define what management is rather than what management does. Management is the process of allocating an organization's inputs, including human and resources, by planning, organizing, directing, and controlling for the purpose of producing goods or services desired by customers so that organizational objectives are accomplished. If management has knowledge of the planning, organizing, directing, and controlling of the business, its decisions can be made on the basis of facts, and decisions are more accurate and timely as a result.
Management Information System: Definition and Roles

A management information system (MIS) is a system or process that provides the information necessary to manage an organization effectively. It is used by managers throughout the organization to help them in directing, planning, coordinating, communicating, and decision-making.

In order to provide past, present and prediction information, an MIS can include software that helps in decision-making, data resources such as databases, the hardware resources of a system, decision support systems, people management and project management applications, and any computerized processes that enable the department to run efficiently.

The importance of maintaining a consistent approach to the development, use, and review of MIS systems within the institution must be an ongoing concern of the managers. MIS should have a clearly defined framework of guidelines, policies or practices, standards, and procedures for the organization. These should be followed throughout the institution in the development, maintenance, and use of all MIS.

MIS is viewed and used at many levels by management. It should be supportive of the institution's longer term strategic goals and objectives. To the other extreme it is also those everyday accounting systems that are used to ensure basic control is maintained over financial record keeping activities.

MIS plays very vital role in the management, administration and operation of the organization. The system ensures that an appropriate data is collected from various sources, processed and sent further to all the needy
destinations. An institution's MIS should be designed to achieve the following goals:

- Enhance communication among employees.
- Deliver complex material throughout the institution.
- Provide an objective system for recording and aggregating information.
- Reduce expenses related to labor-intensive manual activities.
- Support the organization's strategic goals and direction.

**Principles of Management**

Effective MIS should ensure the appropriate presentation formats and time frames required by operations and senior management is met. MIS can be maintained and developed by either manual or automated systems or a combination of both. It should always be sufficient to meet an institution's unique goals and objectives. The effective deliveries of an institution's products and services are supported by the MIS. These systems should be accessible and useable at all appropriate levels of the organization. Below we can summaries the main principles of management:

1. **Division of Work**: Division of work or work specialization results in efficient use of resources and increases productivity. This is applicable to both managerial and technical functions.

2. **Authority and Responsibility**: Authority means right to give order or command. Responsibility is the obligation to achieve objectives.
Responsibility comes with authority. Authority and responsibility pinpoints the accountability of work.

3. **Discipline**: Discipline is absolutely necessary for the smooth running of the organization. Discipline means following rules, regulations, policies and procedures by all employees of organization. There must be clear and fair agreement for observing rules and regulations also punishment for disobedience and indiscipline.

4. **Unity of Command**: An employee should receive orders from one supervisor only to avoid possible confusion and conflict i.e. any worker should not be under control of more than one supervisor. It avoids mistakes and delays in getting work done.

5. **Subordination of Individual Interest to General Interest**: The interests of one employee or group should not be given importance over the interests and goals of organization.

6. **Remuneration**: Compensation and the methods of compensation should be fair to both the employee and the employer. Exploitation of employees of any kind must be avoided.

7. **Centralization**: The centralization of authority and power to some extent is necessary where it is most feasible otherwise there should be decentralization of authority and power for smooth functioning of the organization. A balance between both must be achieved. The objective is the optimum use of the capabilities of personnel.
8. **Scaler Chain of authority**: A scaler (hierarchical) chain of authority extends from the highest to lowest rank of an organization and defines the communication path. However, horizontal communication is also encouraged as long as the managers in the chain are kept informed.

9. **Order**: Order is principle of arrangement of things and people. Everything should occupy its proper place i.e. everything should be in order. Due to good organization and selection the right person should be in the right place. Order leads to the creation of sound organization with efficient management.

10. **Stability of Personnel Tenure**: Stability of tenure of personnel in the organization increases the efficiency of the employees and is a symbol of sound management. Because time is required to become effective in new jobs, high turnover of employees should be prevented. Instability (high turnover) is a symbol of weak management.

11. **Initiative**: Managers should encourage and develop the subordinates to take initiative. It is the result of creative thinking and imagination and helps in formulating, planning also its execution.

**Impact of MIS**

MIS creates an impact on the organization’s function, performance and productivity. With MIS support management of all departments of an organization can become more effective. MIS provides several advantages to the organization:
1. **Ability to link and enable employees:** Electronic communication increases the overall amount of communication within a firm. The most important aspect is that people from the various units of a corporation can interact with each other and thus horizontal communication is promoted. All the obvious advantages of quicker information availability is the outcome of this function of IT but it must also be remembered that too much electronic communication leads to increased alienation of employees due to increased impersonality.

2. **Increases boundary spanning:** An individual can access any information in any part of the organization with the aid of the appropriate technology. This eliminates the need for the repetition of information and thus promotes non-redundancy. If information provided is adequate, one can deal with factors like business risk and uncertainties effectively.

3. **Ability to store and retrieve information at any instance:** means that the organization does not have to rely solely on the fallibility of human error, which is subject to error and erosion. Information can be stored, retrieved and communicated far more easily and effectively. The information support improves the lack of knowledge, enriches experience and improves analytical ability leading to better business judgment. It helps managers to act decisively.

4. **Helps in forecasting and long term planning:** A disciplined IS creates a structured database and knowledge base for all people in the organization. The information available in such a form that it can be used either straight away or using blending and analysis thereby saving manager’s valuable time.
Disadvantage of MIS

However, IT can often lead to information overload, meaning that managers have to sift through an insurmountable amount of stored data and thus hindering timely decision-making. This problem is not as serious as first thought, though. Information overload is not an IT problem but more of a documentation problem. Furthermore, management tends to adapt to IT problems once it gets used to the idea of the new technologies. Inaccurate reporting can lead to flawed decision making and planning. MIS typically extracts data from many different financial and transaction systems running on various computer platforms, which can often lead to inaccurate and inconsistent reports unless appropriate control procedures are in place. Even if the information is accurate, the predefined reports generated by MIS may not always anticipate the information needs of individual managers at all times; or the correct information is not available when needed, or is simply hard to access. Because of these deficiencies in MIS, managers are increasingly turning to interactive decision support systems to obtain the information they need for planning and control.

Functions of Manager

1. **Planning** is the process of determining the goals and objectives and strategies for achieving goals of the organization. When doing planning, managers need to:

   - Write or review the organization’s mission.
   - Identify and analyze opportunities.
- Establish goals.
- Select a course of action to achieve these goals.
- Determine resources needed.

2. **Organizing** means deciding what work needs to be done, assigning the tasks, and arranging them into a decision-making framework. Organization involves evolving the structure of the people working in the organization and their roles. Also organizing involves determining activities required to achieve the established objectives, grouping these activities in a logical basis for handling by persons, managers and, finally assigning persons to the job designed.

3. **Staffing:** The primary purposes of staffing are to find, hire, train, develop, reward and retain the required amount of good people, helping them meet their needs while they help the company meet its goal. This statement addresses several important aspects of staffing including recruiting, training and retaining employees that will benefit the company.

4. **Directing:** is influencing people’s behavior through motivation, communication, group dynamics, leadership and disciples. The purpose of directing is to channel the behaviors of all personnel to accomplish the organization’s mission and objectives while simultaneously helping them accomplish their own career objectives.

5. **Controlling:** is the management function, in which managers set and communicate performance standards for people, processes, and devices. The four steps of the control process are:
- Establishing performance standards.
- Measuring performance.
- Comparing measured performance to established standards.
- Taking corrective action.

6. **Coordinating**: This function brings a harmony and smoothness in the various group activities and individual efforts directed towards goals. It needs synchronizing individual efforts and actions which may differ. This is normally carried out by the authority of top level management. Coordinating includes communicating with others, providing directions and motivating people.
Organization Structure and Theory

An organization is the rational coordination of the activities of a number of people for the achievement of some common explicit purpose or goal, through division of labor or function, and through a hierarchy of authority and responsibility. Overall organizational agreements within an enterprise are provided by organization structure.
The organization's base rests on management's philosophy, values, vision and goals. This in turn drives the organizational culture which is composed of the formal organization, informal organization, and the social environment. The culture determines the type of leadership, communication, and group dynamics within the organization. The workers perceive this as the quality of work life which directs their degree of motivation. The final outcome is performance, individual satisfaction, and personal growth and development. All these elements combine to build the model or framework that the organization operates from. The organization structure is built on four basic principles:

- Hierarchy of authority.
- Specialization.
- Standardization (or formulation).
- Centralization.

Every organization is composed of certain parts. These parts then have their various functions and are interdependent on each other for a smooth functioning of the organization. An organization’s structure is a framework that allot a particular space for a particular department or an individual and shows its relationship to the other. An organizational structure is a mostly hierarchical concept of subordination of entities that collaborate and contribute to serve one common aim. An organization’s structure may be of many types, the most common of these being:

- The hierarchical organizational structure
- The flat organizational structure.
A **hierarchical organizational structure** is what we call the traditional structure or at times, the bureaucratic structure where there are one or more levels between the most junior and the senior most employees. This is the dominant mode of organization among large organizations; most corporations and governments are hierarchical organizations. This hierarchy helps in proper distribution of work but can be harmful in terms of efficiency and decision making. Hierarchical organizational structure has the following characteristics:

1. Low number of subordinates per supervisor.
2. Long chain of command.
3. Greater number of levels.
Flat organization refers to an organizational structure with few or no levels of intervening management between staff and managers. It is much more relaxed and so-called modern in approach where everyone directly reports to a single boss.

The idea is that well-trained workers will be more productive when they are more directly involved in the decision making process, rather than closely supervised by many layers of management. This could provide greater speed in the decision making process but then the boss ends up taking care of a lot of things thus making delegation difficult.

This structure is generally possible only in smaller organizations or individual units within larger organizations. When they reach a critical size, organizations can retain a streamlined structure but cannot keep a completely flat manager-to-staff relationship without impacting productivity. Certain organizational responsibilities may also require a more traditional structure. Some theorize that flat organizations become more traditionally hierarchical.
when they begin to be geared towards productivity. Following are the characteristics of a flat organization.

1. High number of subordinates per supervisor.
2. Short of chain of command.
3. Less number of levels.
4. Eliminates middle level managers.
5. Decentralizes authority to low level managers.

An effective organizational structure shall facilitate working relationships between various entities in the organization and may improve the working efficiency within the organizational units. Organization shall retain a set order and control to enable monitoring the processes. Organization shall support command for coping with a mix of orders and a change of conditions while performing work. Below are the shared features of all organizations:
• Clear division of labor
• Hierarchy
• Explicit rules and procedures
• Impartial judgments
• Technical qualifications for positions
• Maximum organizational efficiency

Organization shall allow for application of individual skills to enable high flexibility and apply creativity. When a business expands, the chain of command will lengthen and the spans of control will widen. When an organization comes to age, the flexibility will decrease and the creativity will fatigue. Therefore organizational structures shall be altered from time to time to enable recovery. If such alteration is prevented internally, the final escape is to turn down the organization to prepare for a re-launch in an entirely new set up. It should be an open system capable of adjusting itself to the changing environment.

Organization and Information Requirements

Organizations have various attributes which distinguish them from each other. No two organizations are similar in all respects. There have to have certain distinctive lines keeping them unique from each other. Information requirements keep varying in accordance with:

• Size of organization.
• Organization structure.
• The Culture it follows.
• Decision Making Structures.
• Interested parties both internal and external.
Information Systems: Definitions and Components

What Is an Information System?

Information system has been defined in terms of two perspectives: one relating to its function; the other relating to its structure. From a functional perspective; an information system is a technologically implemented medium for the purpose of recording, storing, and disseminating linguistic expressions as well as for the supporting of inference making. From a structural perspective; an information system consists of a collection of people, processes, data, models, technology and partly formalized language, forming a cohesive structure which serves some organizational purpose or function.

The functional definition has its merits in focusing on what actual users - from a conceptual point of view- do with the information system while using it. They communicate with experts to solve a particular problem. The structural definition makes clear that IS are socio-technical systems, i.e., systems consisting of humans, behavior rules, and conceptual and technical artifacts.

An information system can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products.

Three activities in an information system produce the information that organizations need to make decisions, control operations, analyze problems, and create new products or services. These activities are input, processing,
and output. Input captures or collects raw data from within the organization or from its external environment. Processing converts this raw input into a more meaningful form. Output transfers the processed information to the people who will use it or to the activities for which it will be used. Information systems also require feedback, which is output that is returned to appropriate members of the organization to help them evaluate or correct the input stage.

![Figure 6: Functions of an information system](image)

**What Is A Computer-Based Information System?**

A computer-based information system (CBIS) is an information system that uses computer technology to perform some or all of its intended tasks. Such a system can include as little as a personal computer and software. Or it may include several thousand computers of various sizes with hundreds of printers, plotters, and other devices, as well as communication networks (wire-line and wireless) and databases. In most cases an information system also includes people. The basic components of information systems are listed below. Note that not every system includes all these components.
Components of Information Systems

1. Resources of people: (end users and IS specialists, system analyst, programmers, data administrators etc.).

2. Hardware: (Physical computer equipments and associate device, machines and media).

3. Software: (programs and procedures).

4. Data: (data and knowledge bases), and

5. Networks: (communications media and network support).

People Resources

• End users: (also called users or clients) are people who use an information system or the information it produces. They can be accountants, salespersons, engineers, clerks, customers, or managers. Most of us are information system end users.

• IS Specialists: people who actually develop and operate information systems. They include systems analysts, programmers, testers, computer operators, and other managerial, technical, and clerical IS personnel. Briefly, systems analysts design information systems based on the information requirements of end users, programmers prepare computer programs based on the specifications of systems analysts, and computer operators operate large computer systems.
Hardware Resources

- Machines: as computers and other equipment along with all data media, objects on which data is recorded and saved.
- Computer systems: consist of variety of interconnected peripheral devices. Examples are microcomputer systems, midrange computer systems, and large computer systems.

Software Resources

Software Resources includes all sets of information processing instructions. This generic concept of software includes not only the programs, which direct and control computers but also the sets of information processing (procedures). Software Resources includes:

- System software, such as an operating system
- Application software, which are programs that direct processing for a particular use of computers by end users.
- Procedures, which are operating instructions for the people, who will use an information system. Examples are instructions for filling out a paper form or using a particular software package.

Data Resources

Data resources include data (which is raw material of information systems) and database. Data can take many forms, including traditional alphanumeric data, composed of numbers and alphabetical and other characters that describe business transactions and other events and entities. Text data, consisting of sentences and paragraphs used in written
communications; image data, such as graphic shapes and figures; and audio data, the human voice and other sounds, are also important forms of data. Data resources must meet the following criteria:

- Comprehensiveness: means that all the data about the subject are actually present in the database.
- Non-redundancy: means that each individual piece of data exists only once in the database.
- Appropriate structure: means that the data are stored in such a way as to minimize the cost of expected processing and storage.

The data resources of IS are typically organized into:

- Processed and organized data—Databases.
- Knowledge in a variety of forms such as facts, rules, and case examples about successful business practices.

**Network Resources**

Telecommunications networks like the Internet, intranets, and extranets have become essential to the successful operations of all types of organizations and their computer-based information systems. Telecommunications networks consist of computers, communications processors, and other devices interconnected by communications media and controlled by communications software. The concept of Network Resources emphasizes that communications networks are a fundamental resource component of all information systems. Network resources include:
• Communications media: such as twisted pair wire, coaxial cable, fiber-optic cable, microwave systems, and communication satellite systems.

• Network support: This generic category includes all of the people, hardware, software, and data resources that directly support the operation and use of a communications network. Examples include communications control software such as network operating systems and Internet packages.

![Diagram of Components of Information System](image.png)

**Figure 7: Components of Information System**

**Difference between Computers and Information Systems**

Computers provide effective and efficient ways of processing data, and they are a necessary part of an information system. An IS, however, involves much more than just computers. The successful application of an IS requires an understanding of the business and its environment that is supported by the
IS. For example, to build an IS that supports transactions executed on the New York Stock Exchange, it is necessary to understand the procedures related to buying and selling stocks, bonds, options, and so on, including irregular demands made on the system, as well as all related government regulations.

In learning about information systems, it is therefore not sufficient just to learn about computers. Computers are only one part of a complex system that must be designed, operated, and maintained. A public transportation system in a city provides an analogy. Buses are a necessary ingredient of the system, but more is needed. Designing the bus routes, bus stops, different schedules, and so on requires considerable understanding of customer demand, traffic patterns, city regulations, safety requirements, and the like. Computers, like buses, are only one component in a complex system.

Information Technology and Information Systems

Information technology broadly defined as the collection of computer systems used by an organization. Information technology, in its narrow definition, refers to the technological side of an information system. It includes the hardware, software, databases, networks, and other electronic devices. It can be viewed as a subsystem of an information system. Sometimes, though, the term information technology is also used interchangeably with information system.

The term IT in its broadest sense used to describe an organization’s collection of information systems, their users, and the management that oversees them.
A major role of IT is being a *facilitator* of organizational activities and processes. That role will become more important as time passes. Therefore, it is necessary that every manager and professional staff member learn about IT not only in his or her specialized field, but also in the entire organization and in inter-organizational settings as well.

Obviously, you will be more effective in your chosen career if you understand how successful information systems are built, used, and managed. You also will be more effective if you know how to recognize and avoid unsuccessful systems and failures. Also, in many ways, having a comfort level with information technology will enable you, off the job and in your private life, to take advantage of new IT products and systems as they are developed. (Wouldn’t you rather be the one explaining to friends how some new product works, than the one asking about it?) Finally, you should learn about IT because being knowledgeable about information technology can also increase employment opportunities. Even though computerization eliminates some jobs, it also creates many more.

The demand for traditional information technology staff—such as programmers, systems analysts, and designers—is substantial. In addition, many excellent opportunities are appearing in emerging areas such as the Internet and e-commerce, m-commerce, network security, object-oriented programming, telecommunications, multimedia design, and document management.

According to a study by the U.S. Bureau of Labor Statistics, each of the top seven fastest-growing occupations projected through 2010 fall within an IT- or computer related field. These top seven occupations are:
1. Computer software applications engineers
2. Computer support specialists
3. Computer software systems engineers
4. Network and computer systems administrators
5. Network systems and data communications analysts
6. Desktop publishers
7. Database administrators

To exploit the high-paying opportunities in IT, a college degree in any of the following fields, or combination of them, is advisable: computer science, computer information systems (CIS), management information systems (MIS), electronic commerce, and e-business. Within the last few years, many universities have started e-commerce or e-business degrees. Many schools offer graduate degrees with specialization in information technology.
Classification and Evolution of Information Systems

Introduction

Information systems are made out of components that can be assembled in many different configurations, resulting in a variety of information systems and applications, much as construction materials can be assembled to build different homes types. The size and cost of a home depend on the purpose of the building, the availability of money, and constraints such as ecological and environmental legal requirements. Just as there are many different types of houses, so there are many different types of information systems. It is useful to classify information systems into groups that share similar characteristics. Such a classification may help in identifying systems, analyzing them, planning new systems, planning integration of systems, and making decisions such as the possible outsourcing of systems. This classification can be done in several alternative ways. Information systems are classified by organizational levels, mode of data processing, system objectives, and by the type of support provided.

1. Classification by Organizational Levels

Organizations are made up of components such as divisions, departments, and work units, organized in hierarchical levels. For example, most organizations have functional departments, such as production and accounting, which report to plant management, which report to a division head. The divisions report to the corporate headquarters. Although some organizations have restructured themselves in innovative ways, such as those based on cross-functional teams, today the vast majority of organizations still
have a traditional hierarchical structure. Thus, we can find information systems built for headquarters, for divisions, for the functional departments, for operating units, and even for individual employees. Such systems can stand alone, but usually they are interconnected.

Typical information systems that follow the organizational structure are *functional* (departmental), *enterprise*, and *inter-organizational*. These systems are organized in a hierarchy in which each higher-level system consists of several (even many) systems from the level below it. At a higher level, the enterprise system supports the entire company, and inter-organizational systems connect different companies.

- **Functional Information Systems**

  Functional organizations are hierarchical structures and center on a strong concept of supervisors and subordinates. The controlling authority, often called top management, coordinates with each management level and functional department to keep the organization running smoothly. A functional organization analyzes the strengths and weaknesses of each member, groups them into categories and assigns them to tasks that best utilize their skills. Jobs that perform a similar function are grouped in functional areas. Each functional area contains employees with varied skills that are further grouped based on specialization and put in separate units or departments. Information systems which served these functional departments are called functional information systems.
Evolution of Functional Organizations

Functional organizations work best when a single product or service is involved. The chain of command is linear, so everyone knows his position in the organization. By clustering specialists with similar skills, leadership, tutoring and guidance concentrate on one area. Employees have an obvious path for growth and promotion, either up or lateral.

As a company gets larger, some of the positives of functional organizations become negatives. Since decisions travel through the chain of command, the process becomes bureaucratic, and information and decisions move slowly. Functional grouping can result in a narrowed overall perspective. Because of communication and decision-making issues, the functional organization is slow to adapt to environmental changes.

- Enterprise Information Systems

While a departmental information system is usually related to a functional area, other information systems serve several departments or the entire enterprise. These information systems together with the departmental applications comprise the enterprise information system (EIS). One of the most popular enterprise applications is enterprise resources planning (ERP), which enables companies to plan and manage the resources of an entire enterprise. ERP systems present a relatively new model of enterprise computing now days.
• **Inter-organizational Information Systems**

Some information systems connect two or more organizations. They are referred to as inter-organizational information systems (IOS's). IOS's support many inter-organizational operations, of which supply chain management is the best known. An organization’s **supply chain** describes the flow of materials, information, money, and services from raw material suppliers through factories and warehouses to the end customers. Note that the supply chain includes both physical flows and information flows. Information flows and digitizable products (e.g., music and software) go through the Internet, whereas physical products are shipped. For example, when you order a computer from [www.dell.com](http://www.dell.com), your information goes to Dell via the Internet. When your transaction is complete (i.e., your credit card is approved and your order is processed), Dell ships your computer to you. Figure below represents information flows and digitizable products (soft products) with dotted lines and physical products (hard products) as solid lines.

![Figure 8: Information flows outside organization in inter-organizational information systems](image_url)
Another example is the worldwide airline reservation system, which is composed of several systems belonging to different airlines. Thousands of travel agents and hundreds of airlines are connected to it. Those that support international or global operations may be especially complex. Inter-organizational information systems play a major role in e-commerce and other web-based e-government information systems applications.

2. Classification by Mode of Data Processing

- Batch Processing Systems: The transactions are collected as they occur, but processed periodically, say, once a day or week.
- On-line Batch Systems: The transaction information is captured by on-line data-entry devices and logged on the system, but it is processed periodically as in batch processing systems.
- On-line Real-time Systems: The transaction data capture as well as their processing in order to update records (and generate reports) is carried out in real-time as the transaction is taking place.

3. Classification by System Objectives

- Transaction Processing Systems (TPS): Their objective is to process transactions in order to update records and generate reports, i.e., to perform score-keeping functions.
- Process Control System (PCS): These systems are designed to make routine decision that control operational processes.
- Decision Support Systems (DSS): Their objective is to support the managerial decisions. Usually, these systems are based on a model of the
decision-making domain, and utilize techniques from management science, finance or other functional areas of business in order to build such models. These systems are also used often for attention-directing purposes, i.e., for directing the attention of managers to a problematic aspect of operations.

- **Expert Systems (ES):** These systems incorporate expertise in order to aid managers in diagnosing problems or in problem solving.
- **Executive Information System (EIS):** These are MIS tailored to the strategic information needs of the top managers.
- **Business Information Systems (BIS):** As a future managerial end user, it is very important to realize that information systems directly support both operations and management activities in business functions of accounting, finance, human resource management, marketing, and operations management. Such business information systems are needed by all business functions.

![Figure 9: Modes of data processing](image)

**Figure 9: Modes of data processing**
4. Classification by the Type of Support Provided

Another way to classify information systems is according to the type of support they provide, regardless of the functional area. For example, an information system can support office workers in almost any functional area. Likewise, managers working from various geographical locations can be supported by a computerized decision-making system.

Clerical workers, who support managers at all levels of the organization, include bookkeepers, secretaries, electronic file clerks, and insurance claim processors. Lower-level managers handle the day-to-day operations of the organization, making routine decisions such as assigning tasks to employees and placing purchase orders. Middle managers make tactical decisions, which deal with activities such as short-term planning, organizing, and control.

Knowledge workers are professional employees such as financial and marketing analysts, engineers, lawyers, and accountants. All knowledge workers are experts in a particular subject area. They create information and knowledge, which they integrate into the business. Knowledge workers act as advisors to middle managers and executives.

Finally, executives make decisions that deal with situations that can significantly change the manner in which business is done. Examples of executive decisions are introducing a new product line, acquiring other businesses, and relocating operations to a foreign country.

Office automation systems (OAS's) typically support the clerical staff, lower and middle managers, and knowledge workers. These employees use OAS to develop documents (word processing and desktop publishing
software), schedule resources (electronic calendars), and communicate (e-mail, voice mail, videoconferencing, and groupware).

Table 2: Types of Organizational Information Systems

<table>
<thead>
<tr>
<th>Type of System</th>
<th>Function</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional area IS</td>
<td>Support the activities within specific functional area.</td>
<td>System for processing payroll</td>
</tr>
<tr>
<td>Transaction processing system</td>
<td>Process transaction data from business events.</td>
<td>Wal-Mart checkout point-of-sale terminal</td>
</tr>
<tr>
<td>Enterprise resource planning system</td>
<td>Integrate all functional areas of the organization.</td>
<td>Oracle, SAP</td>
</tr>
<tr>
<td>Office automation system</td>
<td>Support daily work activities of individuals and groups.</td>
<td>Microsoft Office</td>
</tr>
<tr>
<td>Management information system</td>
<td>Produce reports summarized from transaction data, usually in one functional area.</td>
<td>Report on total sales for each customer</td>
</tr>
<tr>
<td>Decision support system</td>
<td>Provide access to data and analysis tools.</td>
<td>“What-if” analysis of changes in budget</td>
</tr>
<tr>
<td>Expert system</td>
<td>Mimic human expert in a particular area and make a decision.</td>
<td>Credit card approval analysis</td>
</tr>
<tr>
<td>Executive information system</td>
<td>Present structured, summarized information about aspects of business important to executives.</td>
<td>Status of production by product</td>
</tr>
<tr>
<td>Supply chain management system</td>
<td>Manage flows of products, services, and information among organizations.</td>
<td>Wal-Mart Retail Link system connecting suppliers to Wal-Mart</td>
</tr>
<tr>
<td>Electronic commerce system</td>
<td>Enable transactions among organizations and between organizations and customers.</td>
<td><a href="http://www.dell.com">www.dell.com</a></td>
</tr>
</tbody>
</table>
Dimensions of Information

Information can be said to have a number of different characteristics that can be used to describe its quality. The differences between ‘good’ and ‘bad’ information can be identified by considering whether or not it has some or all of the attributes of information quality. Information can be described in terms of personal or organizational dimension.

1. Personal Dimensions of Information:

Personal dimension of information considering three points of view: time, location, and form.

Time Dimension

Information, like many organizational resources, can become old and obsolete. For example, if you want to make a stock trade today, you need to know the price of the stock right now. If you have to wait a day to view stock prices, you may not survive in the turbulent securities market. It’s no wonder that over one-third of all stock transactions today occur over the Internet.

Your information is useful and relevant only if it describes the appropriate time period. For example, most utility companies provide you with a bill that not only tells you of your current usage and the average temperature but also compares that information to the previous month and perhaps the same month last year. This type of information can help you better manage your utilities or simply understand that this month’s high utility bill was caused by inclement weather. The time dimension describes
the time period that the information deals with and the frequency at which the information is received.

♦ **Timeliness**: The information should be available when needed. If information is provided too early, it may no longer be current when used. If the information is supplied too late, it will be of no use.

♦ **Currency**: The information should reflect current circumstances when provided. One can go further and suggest that as well as being up-to-date the information should also indicate those areas or circumstances liable to change by the time the information is used.

♦ **Frequency**: In addition to being available when needed, information should also be available as often as needed. This normally means that information should be supplied at regular intervals, for example some organizations may require weekly sales reports whilst others need only monthly reports.

♦ **Time period**: The information should cover the correct time period. A sales forecast, for example, might include information concerning past performance, current performance and predicted performance so that the recipient has a view of past, present and future circumstances.

**Location Dimension**

The location dimension of information means that having access to information no matter where you are. Ideally, in other words, your location or the information’s location should not matter. You should be able to access information in a hotel room, at home, in the student center of your campus, at work, on the spur of the moment while walking down the street, or even
while traveling on an airplane. This location dimension is closely related to mobile and wireless computing (and also ubiquitous computing) which we’ll discuss in an upcoming section.

To keep certain information private and secure while providing remote access for employees, many businesses are creating intranets. An intranet is an internal organizational Internet that is guarded against outside access by a special security feature called a firewall (which can be software, hardware, or a combination of the two). So, if your organization has an intranet and you want to access information on it while away from the office, all you need is Web access and the password that will allow you through the firewall.

For example, Citigroup’s Global Corporate uses an intranet to provide the entire IT staff with access to all IT projects under construction. Available information includes project owner, delivery date, and numerous budget metrics. Just by making this information easily and securely available to all IT staffers via an intranet, Citigroup has realized an across-the-board 15 percent improvement in on-time delivery of IT projects.

The content dimension describes the scope and contents of the information and considering the following attributes:

♦ **Accuracy**: Information that contains errors has only limited value to an organization.

♦ **Relevance**: The information supplied should be relevant to a particular situation and should meet the information needs of the recipient. Extraneous detail can compromise other attributes of information quality, such as conciseness.
♦ **Completeness:** All of the information required to meet the information needs of the recipient should be provided. Incomplete information can compromise other attributes of information quality, such as scope and accuracy.

♦ **Conciseness:** Only information relevant to the information needs of the recipient should be supplied. In addition, the information should be provided in the most compact form possible. As an example, sales figures are normally provided in the form of a graph or table – it would be unusual for them to be supplied as a descriptive passage of text.

♦ **Scope:** The scope of the information supplied should be appropriate to the information needs of the recipient. The recipient’s information needs will determine whether the information should concern organizational or external situations and whether it should focus on a specific area or provide a more general overview.

**Form Dimension**

The form dimension of information has two primary aspects. The first is simply having information in a form that is most usable and understandable by you—audio, text, video, animation, graphical, and others. The second is accuracy. You need information that is free of errors. Think of information as you would think of a physical product. If you buy a product and it’s defective, you become an unsatisfied customer. Likewise, if you receive information that is incorrect, you’re very unhappy as well. The form dimension describes how the information is presented to the recipient.
♦ **Clarity:** The information should be presented in a form that is appropriate to the intended recipient. The recipient should be able to locate specific items quickly and should be able to understand the information easily.

♦ **Detail:** The information should contain the correct level of detail in order to meet the recipient’s information needs. For example, in some cases highly detailed information will be required whilst in others only a summary will be necessary.

♦ **Order:** Information should be provided in the correct order. As an example, management reports normally contain a brief summary at the beginning. This allows a manager to locate and understand the most important aspects of the report before examining it at a higher level of detail.

♦ **Presentation:** The information should be presented in a form that is appropriate to the intended recipient. Different methods can be used to make information clearer and more accessible to the recipient, for example it is common to present numerical information in the form of a graph or table.

♦ **Media:** Information should be presented using the correct medium. Formal information, for example, is often presented in the form of a printed report, whereas a presentation might make use of a slide projector.
Additional Characteristics

In addition to the attributes described above, one might also add several others. Of particular importance is confidence in the source of the information received. Recipients are more likely to accept and trust the information they obtain if it is received from a source that has been accurate and reliable in the past.

A further attribute of information quality is that of reliability. It can be argued that recipients should be confident that they can rely upon information being available when required and that the information will be of a consistent quality in terms of other attributes of information quality, such as accuracy and conciseness.

The widespread use of computer-based information systems raises a number of issues related to the sheer quantity of information that is freely
available via sources such as the Internet. In addition, the use of computer-based information systems also raises concerns in relation to security. In view of this, one might suggest that a further attribute of information quality is that the information provided should be *appropriate* to the recipient’s activities. This might restrict information from being supplied if it is of a confidential nature or beyond the duties or responsibilities of a person’s role.

It also seems natural to suggest that some confirmation that the information has been *received by the correct person* is required. Unless the information has been received and acted upon, then it is of no value. Thus, it can be suggested that an additional attribute of information quality is that it can be verified that the information has been received and understood.

Finally, it can be argued that another attribute of information quality is that that information should be capable of being *transmitted via the correct channels*. Most organizations have formal policies and procedures for dealing with particular situations. For example, a complaint against a member of staff is normally presented in a written form and travels upwards through the management hierarchy until it is received by the correct person. If the information were to be sent in any other way, for example by word of mouth, it might not reach its destination or might become garbled during the journey.

Table-3 summarizes information characteristics that can be used to assess quality. Note that each column is independent; reading down each column lists the attributes associated with a particular factor.
Table 3: Summary of attributes of information quality

<table>
<thead>
<tr>
<th>Time</th>
<th>Content</th>
<th>Form</th>
<th>Additional characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeliness</td>
<td>Accuracy</td>
<td>Clarity</td>
<td>Confidence in source</td>
</tr>
<tr>
<td>Currency</td>
<td>Relevance</td>
<td>Detail</td>
<td>Reliability</td>
</tr>
<tr>
<td>Frequency</td>
<td>Completeness</td>
<td>Order</td>
<td>Appropriateness</td>
</tr>
<tr>
<td>Time period</td>
<td>Conciseness</td>
<td>Presentation</td>
<td>Received by correct person</td>
</tr>
<tr>
<td></td>
<td>Scope</td>
<td>Media</td>
<td>Sent by correct channels</td>
</tr>
</tbody>
</table>
2. Organizational Dimensions of Information

   The Organizational Dimensions of Information includes information flows, information granularity, and what information describes.

A. Information Flows

   Information in an organization flows in four directions: up, down, horizontally, and inward/outward. To consider these flows, let’s briefly review the structure of an organization. Most people view a traditional organization as a pyramid with four levels and many sides (see Figure 12). From top to bottom, the levels are:

   • Strategic management, which provides an organization with overall direction and guidance.
   • Operational management, which manages and directs the day-to-day operations and implementations of the goals and strategies.
   • Tactical management, which develops the goals and strategies outlined by strategic management.
   • Non-management employees, who actually perform daily activities, such as order processing, developing and producing goods and services, and serving customers.

   If you consider your college as an example, strategic management might include the chancellor, president, and various vice presidents. Tactical management would include the deans. Operational management would include the department chairs and directors of academic programs. The final level would include instructors who are responsible for teaching your classes.
Figure 11: Structure of traditional organization as a pyramid

Information that flows upward, or the **upward flow of information**, describes the current state of the organization based on its daily transactions. When a sale occurs, for example, that information originates at the lowest level of the organization that then is passed up through various levels of management. Information that is gathered as a part of everyday operations is consolidated by information technology and passed upward to decision makers who monitor and respond to problems and opportunities.

The **downward flow of information** consists of the strategies, goals, and directives that originate at one level and are passed to lower levels. Many organizations are taking advantage of collaborative technologies and systems to share and move this type of information.

Information that flows horizontally, or the **horizontal flow of information**, is between functional business units and work teams. For example, at your school various departments are responsible for scheduling
courses. That information is passed horizontally to the registrar’s office, which creates a course schedule for your entire campus (which may be online—timely and accessible from anywhere by you). Again, collaborative technologies and systems support the horizontal flow of information.

Finally, the **outward and inward flows of information** consist of information that is communicated to customers, suppliers, distributors, and other partners for the purpose of doing business. These flows of information are really what electronic commerce is all about. Today, no organization is an island, and you must ensure that your organization has the right information technology to communicate with all types of business partners.

![Figure 12: An Organization, Its Information Flows, and Information Granularity](image-url)
B. Information Granularity

Figure 12 also illustrates another dimension of information. **Information granularity** refers to the extent of detail within the information. On one end of this spectrum is coarse granularity, or highly summarized information. At the other end is fine granularity, or information that contains a great amount of detail. Peoples in the highest levels of the organization deal mainly with a coarse granularity of information, with sales by year being an example. People in the lowest levels of the organization, on the other hand, need information with fine granularity. If you consider sales again, non-management employees need information in great detail that describes each transaction when it occurred, whether by credit or cash... "Who made the sale, to whom that sale was made", and so on.

So, when transaction information originates at the lowest level of an organization (with fine granularity), it is consolidated by IT to a coarser granularity as it moves up through the organization (the upward flow of information).

C. What Information Describes

Another organizational dimension of information is what the information describes? Information can be internal, external, objective, subjective, or some combination of the four.

- Internal information describes specific operational aspects of an organization.
- External information describes the environment surrounding the organization.
- Objective information quantifiably describes something that is known.
- Subjective information attempts to describe something that is unknown.

Consider a bank that faces a decision about what interest rate to offer. That bank will use internal information (how many customers it has), external information (what rate other banks are offering), objective information (what is today’s prime interest rate), and subjective information (what prime interest rate is expected in the future). Actually, the rate other banks are offering is not only external information (it describes the surrounding environment) but objective information (it is quantifiably known). Information often has more than one aspect to it.

As a general rule, peoples in the lowest level of the organization deal mainly with internal and objective information. People in the highest levels of the organization, on the other hand, deal with all types of information.
Relationships between Information Systems and Organizations

Because there are different interests, specialties, and levels in an organization, there are different kinds of systems. No single system can provide all the information an organization needs. Figure (13) illustrates one way to depict the kinds of systems found in an organization. In the illustration, the organization is divided into strategic, management, and operational levels and then is further divided into functional areas, such as sales and marketing, manufacturing and production, finance and accounting, and human resources. Systems are built to serve these different organizational interests.

Figure: 13 Types of information systems
Different Kinds of Systems

Three main categories of information systems serve different organizational levels: operational-level systems, management-level systems, and strategic-level systems.

- **Operational-level systems**: support operational activities by keeping track of the elementary activities and transactions of the organization, such as assigning employees to tasks and recording the number of hours they work, or placing a purchase order. Operational activities are short-term in nature. The information systems that support them are mainly Operational systems are used by supervisors (first-line managers), operators, and clerical employees. The principal purpose of systems at this level is to answer routine questions and to track the flow of transactions through the organization. How many parts are in inventory? What happened to Mr. Williams’s payment? To answer these kinds of questions, information generally must be easily available, current, and accurate. Examples of operational-level systems include a system to record bank deposits from ATM (Automatic Teller Machines) or one that tracks the number of hours worked each day by employees on a factory floor.

- **Management-level systems**: serve the monitoring, controlling, decision-making, and administrative activities of middle managers. The principal question addressed by such systems is this: Are things working well? Management-level systems typically provide periodic reports rather than instant information on operations. Some management-level systems
support no routine decision making. They tend to focus on less-structured decisions for which information requirements are not always clear. These systems often answer “what-if” questions: What would be the impact on production schedules if we were to double sales in the next month? What would happen to our return on investment if a factory schedule were delayed for six months? Answers to these questions frequently require new data from outside the organization, as well as data from inside that cannot be easily drawn from existing operational-level systems. Management-level systems are broader in scope than operational-level systems, but like operational systems, they use mainly internal sources of data. They provide the types of support shown in Table 4.

Table: 4 Supports provided by MIS

<table>
<thead>
<tr>
<th>Task</th>
<th>MIS Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistical summaries</td>
<td>Summaries of new data (e.g., daily production by item, monthly electricity usage).</td>
</tr>
<tr>
<td>Exception reports</td>
<td>Comparison of actual performances to standards (or target). Highlight only deviations from a threshold (e.g., above or below 5%).</td>
</tr>
<tr>
<td>Periodic reports</td>
<td>Generated at predetermined intervals.</td>
</tr>
<tr>
<td>Ad-hoc reports</td>
<td>Generated as needed, on demand. These can be routine reports or special ones.</td>
</tr>
<tr>
<td>Comparative analysis and early detection of problems</td>
<td>Comparison of performance to metrics or standards. Includes analysis such as trends and early detection of changes.</td>
</tr>
<tr>
<td>Projections</td>
<td>Projection of future sales, cash flows, market share, etc.</td>
</tr>
<tr>
<td>Automation of routine decision</td>
<td>Standard modeling techniques applied to routine decisions such as when and how much to order or how to schedule work.</td>
</tr>
<tr>
<td>Connection and collaboration</td>
<td>Internal and external Web-based messaging systems, e-mail, voice mail, and groupware</td>
</tr>
</tbody>
</table>
• **Strategic-level systems**: help senior management address strategic issues and long-term trends, both in the firm and in the external environment. Strategic activities are basically decisions that deal with situations that significantly may change the manner in which business is done. Traditionally, strategic decisions involved only long-range planning. A long-range planning document traditionally outlines strategies and plans for the next five or even 10 years. From this plan, companies derive their shorter-range planning, budgeting, and resource allocation. In the digital economy, the planning period has been dramatically reduced to one or two years, or even months.
**Transaction Processing Systems**

Transaction processing systems (TPS's) were among the earliest computerized systems. Their primary purpose is to record, process, validate, and store transactions that take place in the various functional areas of a business for future retrieval and use.

Transaction processing systems are cross-functional information systems that process data resulting from the occurrence of business transactions, such as sales, purchases, deposits, withdrawals, refunds, and payments. A TPS is also acts as main link between the organization and external entities, such as customers' suppliers, distributors, and regulatory agencies.

Transaction processing systems serve the operational level of the organization. It is a computerized system that performs and records the daily routine transactions necessary to manage business; they serve the organization’s operational level. The principal purpose of systems at this level is to answer routine questions and to track the flow of transactions through the organization. Examples are hotel reservation systems, payroll, employee record keeping, and shipping. At the operational level, tasks, resources, and goals are *predefined and highly structured*. The decision to grant credit to a customer, for instance, is made by a lower level supervisor according to predefined criteria. All that must be determined is whether the customer meets the criteria. Figure (14) depicts a payroll TPS, which is a typical accounting transaction processing system found in most firms. A payroll system keeps track of the money paid to employees. The master file is composed of discrete pieces of information (such as a name, address, or employee number) called data elements. Data are keyed into the system,
updating the data elements. The elements on the master file are combined in different ways to make up reports of interest to management and government agencies and to send paychecks to employees. These TPS can generate other report combinations of existing data elements.

Figure: 14  A symbolic representation for a payroll TPS

A payroll system is a typical accounting TPS that processes transactions such as employee time cards and changes in employee salaries and deductions. It keeps track of money paid to employees, withholding tax, and paychecks.
Types of Transaction Processing System (TPS's)

1. **On-line system:** involves a direct connection between operator and the TPS program. They provide immediate result and used to process a single transaction at a time. Ex: an order arrives by telephone call; it is processed at that moment and the result are produced.

2. **Batch-processing system:** This is a second type of TPS, where transactions are grouped together and processed as a unit. Example: cheque processing system in a bank.

Types of Transactions:

1. **Internal Transactions:** Those transactions, which are internal to the company and are related with the internal working of any organization. For example Recruitment Policy, Promotion Policy, Production policy etc.

2. **External Transactions:** Those transactions, which are external to the organization and are related with the external sources, are regarded as External Transaction. For example sales, purchase etc.

TPS Properties:

1. **Consistency:** The transaction is a correct transformation of the state. This means that the transaction is a correct program.

2. **Isolation:** Even though transactions execute concurrently, it appears to the outside observer as if they execute in some serial order. Isolation is required to guarantee consistent input, which is needed for a consistent program to provide consistent output.
3. **Reliability**: TPS system is designed to ensure that all transactions are entered in sequential and systematic manner.

4. **Standardization**: Transactions must be processed in the same way each time to maximize efficiency and effectiveness.

5. **Controlled Access**: Since TPS also contains confidential matters or data; it acts as powerful tool for the organization. Hence access must be restricted.

### Objectives (Goals) of TPS

1. Process data generated by and about transactions.
2. Maintain a high degree of accuracy.
3. Ensure data and information integrity and accuracy.
4. Produce timely documents and reports.
5. Increase labor efficiency.
6. Help provide increased and enhanced service.
7. Help build and maintain customer loyalty.
8. Achieve competitive advantage.

### Major Characteristics of TPS

1. TPS handles data which shows the results of various activities on historical basis i.e., activities which have already happened.
2. It is relevant to all functional areas inside organization i.e. (production, marketing, finance and human resources) because each area has some kind of transaction.
3. TPS helps to assess the organizational performance.
4. The sources of data are mostly internal, and the output is intended mainly for an internal audience.
5. The TPS processes information on a regular basis: daily, weekly, monthly, annually etc.
6. It provides high processing speed to handle the high volume of data.
7. Input and output data are structured (i.e., standardized).
8. A high level of accuracy, data integrity, and security is needed which is provided by TPS.

Transaction Processing Activities

1. Data collection: Capturing data necessary for the transaction.
2. Data editing: Check validity and completeness of data.
3. Data correction: Correct the wrong data.
5. Data storage: Update transactions (on Databases).
6. Document production and reports: Create end result reports.

Figure 15: Transaction Processing Activities
**Transaction Models**

As the transaction environment evolves from the centralized environment to distributed and mobile environments, the properties and the structure of transactions change. However, several basic transaction models are indispensable. In this section, we will review the following transaction models:

1. Flat transaction model.
2. Nested transaction model.
3. Multilevel transaction model.
4. Sagas transaction model.
5. Split and Join transaction model.

**Flat Transaction Model**

The flat transaction model presents the simplest transaction structure that fully meets the TPS properties. Figure 16 illustrates the structure of a flat transaction. The building block of a flat transaction, between Begin and Commit /Abort operations, contains all the database operations that are tightly coupled together as one atomic database operation. The flat transaction begins at one consistent database state, and either ends in another consistent state, i.e., the transaction commits, or remains in the same consistent state, i.e., the transaction aborts.
Nested Transaction Model

The nested transaction model defines the concepts and the mechanisms for breaking up the large building block of a flat transaction into a set of smaller transactions, called sub-transactions. Thus, the nested transaction model has a hierarchical tree structure that includes a top-level transaction and a set of sub-transactions (either parent or children transactions). Sub-transactions at the leaf level of the transaction tree are flat transactions.
The multilevel transaction model is looser than the nested transaction model in terms of the relationship between parent and children transactions. Sub-transactions in the multilevel transaction can commit or abort independently of their parents. This is supported by the concepts of compensating transactions. We will briefly discuss the concept of compensating transactions, and its opposed contingency transactions (see Figure 18).

- Compensating Transactions are designed to undo the effect of the original transactions that have aborted. The compensating transactions are triggered and started when the original transactions fail. Otherwise, the compensating transactions are not initiated. Once a compensating transaction has started, it must commit. In other words, the compensating transactions can not abort. If a compensating transaction fails, it will be restarted.
- Contingency Transactions are designed to replace the task of the original transactions that have failed. Contingency transactions are also triggered by the failures of the original transactions. Note that it is not always possible to specify the compensating or contingency transactions for an original transaction.

![Figure 18: Compensating and Contingency Transactions](image)

**Sagas Transaction Model**

The Sagas transaction model also makes use of the concept of compensating transactions to support transactions whose execution time is long. A Sagas transaction consists of a consecutive chain of flat transactions Si that can commit independently. For each flat transaction Si, there is a compensating transaction CPi that will undo the effect of the transaction Si if the transaction Si aborts. A compensating transaction CPi in the Sagas chain is triggered by the associated transaction Si or the compensating transaction CPi+1. If the Sagas transaction commits, no compensating transaction CPi is initiated (see Figure 19-a), otherwise the chain of compensating transactions is triggered (see Figure 19-b).
The Split and Join transaction model was proposed to support the open ended activities that associate with transactions. The Split and Join transaction model focuses on activities that have uncertain duration, uncertain developments, and are interactive with other concurrent activities. The main idea is to divide an ongoing transaction into two or more serializable transactions, and to merge the results of several transactions together as one atomic unit. In other words, the Split and Join transaction model supports reorganizing the structure of transactions (as illustrated in Figure 20).

Figure 19: Successful and Unsuccessful Sagas

**Split and Join Transaction Model**

The Split and Join transaction model was proposed to support the open ended activities that associate with transactions. The Split and Join transaction model focuses on activities that have uncertain duration, uncertain developments, and are interactive with other concurrent activities. The main idea is to divide an ongoing transaction into two or more serializable transactions, and to merge the results of several transactions together as one atomic unit. In other words, the Split and Join transaction model supports reorganizing the structure of transactions (as illustrated in Figure 20).
Transactions on a Transaction-Oriented Database System

A transaction processing system plays a role as a mediator that accepts transaction requests from users, dispatches these requests to the database system, coordinates the execution of the involved transactions, and forwards transaction results to the original acquirers.

The common programming model for a transaction-oriented database system is the client-server model. Users or clients interact with the database system by submitting their transaction processes that consist of one or many database operations to the transaction processing system. The transaction processing system will coordinate and manage the execution of these transaction processes by subsequently sending these database operations to the database system. The database system will carry out the actual execution of the submitted database operations. Finally, the transaction results that reflect the consistent states of the database system are returned to the clients.
Figure 21: Transaction-oriented database system

Figure 22: Dataflow of transaction-oriented database systems
To protect the integrity constraint of the database system, a set of essential components that includes a transaction manager, a scheduling manager and a log manager are deployed. Additional components such as communication manager or other resource managers can also be employed by the transaction processing system.

![Transaction processing system components](image)

**Figure 23: Transaction processing system components**

The role of each transaction processing component is described as follows:

1. **Transaction Manager.** The role of the transaction manager is to orchestrate the execution of transactions. Via the help of the scheduling and log managers (explained below), the transaction manager takes care of all important operations of transactions such as begin, read, write, commit, and abort (or rollback). If the execution of a transaction is distributed to many different resource managers, the transaction manager will act as the coordinator of the involved participants.
2. **Scheduling Manager.** The scheduling manager manages the order of execution of the database operations. Usually, the scheduling manager makes use of concurrency control protocols, for example locking or timestamp protocols, in order to control the execution of transactions. Thus, the scheduling manager supports the isolation and consistency properties of transactions. Based on the applied concurrency control protocol, the scheduling manager will determine an execution order in which the submitted database operations will be carried out. For example, if a locking protocol is used, the scheduling manager will decide whether a lock request will be granted to the acquired transaction, or if a timestamp protocol is applied, the scheduling manager will assess if a submitted operation will be allowed to be carried out.

3. **Log Manager.** The role of the log manager is to support the database system to recover from failures. The log manager keeps track of the changes of the database states by recording the history of transaction execution. Depending on the deployed recovery strategies, for example undo and/or redo, the log manager will record necessary information in a non-volatile logbook. The log manager ensures the atomicity and the durability properties of transactions.
Management Information Systems

Management information systems (MIS) designates a specific category of information systems serving management-level functions. Typically, MIS have large quantities of input data and they produce summary reports as output. MIS are oriented almost exclusively to internal, not environmental or external, events.

MIS primarily serve the functions of **planning, controlling, and decision making** at the management level. Generally, they depend on underlying transaction processing systems for their data. MIS summarize and report on the company’s basic operations.

MIS converts TPS data into information for monitoring performance and managing an organization. Transactions recorded in a TPS are analyzed and reported by an MIS. Management information systems serve the management level of the organization, providing managers with reports and often online access to the organization’s current performance and historical records. The basic transaction data from TPS are compressed and are usually presented in long reports that are produced on a regular schedule. Figure (24) shows how a typical MIS transforms transaction level data from inventory, production, and accounting into MIS files that are used to provide managers with reports. In the system illustrated by this diagram, three TPS supply summarized transaction data to the MIS reporting system at the end of the time period. Managers gain access to the organizational data through the MIS, which provides them with the appropriate reports.
MIS usually serve managers primarily interested in weekly, monthly, and yearly results, although some MIS enable managers to drill down to see daily or hourly data if required. MIS generally provide answers to routine questions that have been specified in advance and have a predefined procedure for answering them. For instance, MIS reports might compare total annual sales figures for specific products to planned targets as shown in Table 6. These systems are generally not flexible and have little analytical capability. Most MIS use simple routines such as summaries and comparisons, as opposed to sophisticated mathematical models or statistical techniques.
Table 5: Functions of MIS

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Processing</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Transactions</td>
<td>Sorting</td>
<td>Summary reports</td>
</tr>
<tr>
<td>Internal Files</td>
<td>Merging</td>
<td>Action reports</td>
</tr>
<tr>
<td>Structured data</td>
<td>Summarizing</td>
<td>Detailed reports</td>
</tr>
</tbody>
</table>

Table 6: A sample MIS report

<table>
<thead>
<tr>
<th>PRODUCT CODE</th>
<th>PRODUCT DESCRIPTION</th>
<th>SALES REGION</th>
<th>ACTUAL SALES</th>
<th>PLANNED</th>
<th>ACTUAL versus PLANNED</th>
</tr>
</thead>
<tbody>
<tr>
<td>4469</td>
<td>Carpet Cleaner</td>
<td>Northeast</td>
<td>4,066,700</td>
<td>4,800,000</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South</td>
<td>3,778,112</td>
<td>3,750,000</td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Midwest</td>
<td>4,867,001</td>
<td>4,600,000</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>West</td>
<td>4,003,440</td>
<td>4,400,000</td>
<td>0.91</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>16,715,253</td>
<td>17,550,000</td>
<td>0.95</td>
</tr>
<tr>
<td>5674</td>
<td>Room Freshener</td>
<td>Northeast</td>
<td>3,676,700</td>
<td>3,900,000</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South</td>
<td>5,608,112</td>
<td>4,700,000</td>
<td>1.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Midwest</td>
<td>4,711,001</td>
<td>4,200,000</td>
<td>1.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>West</td>
<td>4,563,440</td>
<td>4,900,000</td>
<td>0.93</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>18,559,253</td>
<td>17,700,000</td>
<td>1.05</td>
</tr>
</tbody>
</table>
Decision-Making in Modern Organizations

The word "decision" is derived from the Latin root "decido"; which means 'to cut off'. The concept of decision, therefore, is settlement, a fixed intention bringing to a conclusive result, a judgment, and a resolution.

Individuals throughout organizations use the information they gather to make a wide range of decisions. These decisions may affect the lives of others and change the course of an organization. A decision is the choice out of several options made by the decision maker to achieve some objective in a given situation.

Decision Making Concepts

Much of managerial work is decision making. Managers often have to consider large amounts of data, synthesis from them only relevant information and make decisions that will best benefit the organization. Hence, information should be conceived and able to prove their value as information system should support and assist effective decision-making.

Because of the importance of high-quality decision making, firms are investing heavily in decision making and intelligence systems, which consist of technologies and applications designed to help users make better decisions. When we think of intelligence as applied to humans, we typically think of people’s ability to combine learned knowledge with new information and change their behavior in such a way that they succeed at their task or adapt to a new situation.

The decision-making process is a complex process in the higher hierarchy of management. The complexity is the result of many factors, such as the
interrelationship among the experts or decision makers, a job responsibility, a question of feasibility, the codes of morals and ethics, and a probable impact on business.

The personal values of the decision maker play a major role in decision-making. A decision otherwise being very sound on the business principle and economic rationality may be rejected on the basis of the personal values, which are defeated if such a decision is implemented. The culture, the discipline and the individual's commitment to goals will decide the process and success of the decision.

Whatever may be the situation, if one analyses the factors underlying the decision-making process, it would be observed that there are common characteristics in each of them. There is a definite method of arriving at a decision; And it can be put in the form of decision process model.

The decision-making process requires creativity, imagination and a deep understanding of human behavior. The process covers a number of tangible and intangible factors affecting the decision-making process. It also requires a foresight to predict the post decision implications and a willingness to face those implications. All decisions solve a "problem" but over a period of time they give rise to a number of other problems.

Types of Decisions

- **Structured decisions** follow a set of rules. This means that: decisions can be taken objectively there is a clearly defined method of solving the problem generally, there is a right answer. There are a number of operational
research techniques to help reach structured decisions. These include linear programming and network analysis.

- **Unstructured decisions** are normally subjective and do not follow any definite set of rules. (Efforts are made to turn unstructured decisions into structured ones by setting hard-and-fast criteria.).

- **Semi-structured decisions** lie between structured and unstructured decisions. Some parts of the decision making process are programmable (structured), others not.

![Figure 25: Information Requirements of Decision-Making inside organization](image)

There are different types of decision-making at different levels; senior executives face many unstructured decision situations, such as establishing the firm's five or ten-year goals. Middle management faces more structured decision scenarios but their decisions may include unstructured components.
Operational management and rank-and-file employees tend to make more structured decisions.

**Table 7: Examples of Decisions Commonly Made Within Organizations**

<table>
<thead>
<tr>
<th>Level of Decision</th>
<th>Examples of Decision</th>
<th>Who Typically Makes Decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Decisions</td>
<td>Should we merge with another company? Should we pursue a new product line? Should we downsize our organization?</td>
<td>Top Management Teams, CEOs, and Boards of Directors</td>
</tr>
<tr>
<td>Tactical Decisions</td>
<td>What should we do to help facilitate employees from the two companies working together? How should we market the new product line? Who should be let go when we downsize?</td>
<td>Managers</td>
</tr>
<tr>
<td>Operational Decisions</td>
<td>How often should I communicate with my new coworkers? What should I say to customers about our new product? How will I balance my new work demands?</td>
<td>Employees throughout the organization</td>
</tr>
</tbody>
</table>

**Other types of decisions are:-**

*Analytical decisions:* An analytical decision is one that is based on an analysis of information that has been systematically acquired and evaluated. Much of the information will be quantitative.
Heuristic decisions: These solutions will usually depend on trial and error. Common sense, past experience and general guidelines may be used to help, but the decision maker is not applying any techniques that will guarantee the correct answer first time.

Generally, not all decisions have major consequences or even require a lot of thought. For example, before you come to class, you make simple and habitual decisions such as what to wear, what to eat, and which route to take as you go to and from home and school. You probably do not spend much time on these mundane decisions. These types of straightforward decisions are termed programmed decisions, or decisions that occur frequently enough that we develop an automated response to them. The automated response we use to make these decisions is called the decision rule. For example, many restaurants face customer complaints as a routine part of doing business. Because complaints are a recurring problem, responding to them may become a programmed decision. The restaurant might enact a policy stating that every time they receive a valid customer complaint, the customer should receive a free dessert, which represents a decision rule.

On the other hand, unique and important decisions require conscious thinking, information gathering, and careful consideration of alternatives. These are called non-programmed decisions. For example, in 2007 McDonald’s Corporation became aware of the need to respond to growing customer concerns regarding the unhealthy aspects (high in fat and calories) of the food they sell. This is a non-programmed decision, because for several decades, customers of fast-food restaurants were more concerned with the
taste and price of the food, rather than its healthiness. In response to this problem, McDonald’s decided to offer healthier alternatives such as the choice to substitute French fries in Happy Meals with apple slices and later they banned the use of trans fat at their restaurants.

Decision makers have to choose among the policies that contain various mixes of conflicting goals. This is especially evident in the strategic level. As a result, decision-making systems are useful to assist this situation. The decision making process can be broken down into five stages, namely:-

1. **Trigger**: (find what to fix): Find or recognize a problem, need, or opportunity (also called the diagnostic phase of decision making). This phase involves detecting and interpreting signs that indicate a situation which needs your attention. These “signs” come in many forms: consistent customer requests for new-product features, the threat of new competition, declining sales, rising costs, an offer from a company to handle your distribution needs, and so on.

2. **Information gathering**: Identifies preliminary information needs; obtain information.

3. **Design**: (find fixes): Consider possible ways of solving the problem, filling the need, or taking advantage of the opportunity. In this phase, you develop all the possible solutions you can.

4. **Choice**: (pick a fix): Examine and weigh the merits of each solution, estimate the consequences of each, and choose the best one (which may be to do nothing at all). The “best” solution may depend on such factors as cost, ease of implementation, staffing requirements, and timing. This is the
prescriptive phase of decision making—it’s the stage at which a course of action is prescribed.

5. **Evaluation**: (apply the fix): Carry out the chosen solution, monitor the results, and make adjustments as necessary. Simply implementing a solution is seldom enough. Your chosen solution will always need fine-tuning, especially for complex problems or changing environments.

This five-phase process is not necessarily linear: You’ll often find it useful or necessary to cycle back to an earlier phase. When choosing an alternative in the choice phase, for example, you might become aware of another possible solution. Then you would go back to the design phase, include the newly found solution, return to the choice phase, and compare the new solution to the others you generated.

![Figure 26: Decision making process phases](image.png)
Making Rational Decision-making

The rational decision-making model describes a series of steps that decision makers should consider if their goal is to maximize the quality of their outcomes. In other words, if you want to make sure that you make the best choice, going through the formal steps of the rational decision-making model may make sense.

Let’s imagine that your old car has broken down, and you have enough money saved for a substantial down payment on a new car. It will be the first major purchase of your life, and you want to make the right choice. The first step, therefore, has already been completed—we know that you want to buy a new car. Next, in step 2, you’ll need to decide which factors are important to you. How many passengers do you want to accommodate? How important is fuel economy to you? Is safety a major concern? You only have a certain amount of money saved, and you don’t want to take on too much debt, so price range is an important factor as well. If you know you want to have room for at least five adults, get at least 20 miles per gallon, drive a car with a strong safety rating, not spend more than $20,000 on the purchase, and like how it looks, you have identified the decision criteria. All the potential options for purchasing your car will be evaluated against these criteria. Before we can move too much further, you need to decide how important each factor is to your decision in step 3. If each is equally important, then there is no need to weigh them, but if you know that price and mpg are key factors, you might weigh them heavily and keep the other criteria with medium importance. Step 4 requires you to generate all alternatives about your options. Then, in step 5, you need to use this information to evaluate each alternative against
the criteria you have established. You choose the best alternative (step 6), and then you would go out and buy your new car (step 7).

Of course, the outcome of this decision will influence the next decision made. That is where step 8 comes in. For example, if you purchase a car and have nothing but problems with it, you will be less likely to consider the same make and model when purchasing a car the next time.

![Figure 27: Steps in the Rational Decision-Making Model](image)

While decision makers can get off track during any of these steps, research shows that searching for alternatives in the fourth step can be the most challenging and often leads to failure.

According to "Simon Herbert" we can differentiates among the types of rationality. A decision, in a given situation is:

- Objectively rational if it maximizes the value of the objective.
- Subjectively rational if it maximizes the attainment of value within limitation of the knowledge and awareness of the subject.
• Consciously rational to the extent the process of the decision-making is deliberate and a conscious one.
• Organizationally rational to the degree of the orientation towards the organization.
• Personally rational to the extent it achieves an individual's personal goals.

The Problems in Making Rational Decisions

(a) Ascertaining the problem: The most common source of mistakes in the management decisions is the emphasis on finding the right answers rather than the right questions. The main task is to define the right problem in clear terms. For example, the management may define the problem as the "Sales are declining". Actually, the decline of sales is symptomatic; The real problem may be somewhere else. The problem may be the poor quality of the product and you may be thinking of improving the quality of advertising.

(b) Insufficient knowledge: For perfect rationality, total information leading to complete knowledge is necessary. An important function of a manager is to determine whether the dividing line is reached between insufficient knowledge and the enough information to make a decision.

(c) Not enough time to be rational: The decision maker is under pressure to make decisions. If time is limited, he may make hasty decisions which may not satisfy the test of rationality of the decision.
(d) The environment may not cooperate: Sometimes, the timing of the decision is such that one is forced to make a decision but the environment is not conducive for it. The decision may fail the test of rationality as the environmental factors considered in the decision-making turn out to be untrue. For example, in a product pricing, the factor of oil and petroleum product price is considered as stable. But the post decision environment proves the consideration to be wrong.

(e) Other limitations: Other limitations are the need for a compromise among the different positions, misjudging the motives and values of people, poor communications, misappraisal of uncertainties and risks, and inability to handle the available knowledge and human behavior. How do we then ensure rationality? It is ensured, if the process of decision-making is carried out systematically, whereby all the aspects of the decision-making discussed above are taken care of. Herbert Simon said that a decision maker follows the process of decision-making disregarding the decision or the type of decision and the motive behind the decision. This process is followed consciously or without knowing it. We can put this process in the Decision-Making Model.
**Decision Support Systems (DSS)**

**Introduction to DSS**

DSS is an interactive, flexible computer based information system. It uses rules and models for processing data, to support various managerial levels, ranging from top executives to managers, in their decision-making.

A DSS is usually built to support the solution of certain problem and does not replace the decision maker. As such, it is called a DSS application. It is user friendly with strong graphical capabilities.

**Components of Decision Support System**

The components of a DSS include a database of data used for query and analysis, software with models, data mining and other analytical tools and a user interface.

The DSS database is a collection of current or historical data from a number of applications or groups. It can be small database or a massive data warehouse from a large company, which is continuously being updated.

The DSS software system includes software tools for data analysis. They contain various OLAP tools (online analytical processing enables users to interactively analyze multidimensional data from multiple perspectives), data mining tools or a collection of mathematical and analytical models. A model can be a physical model, a mathematical model or a verbal model. Most commonly used are the statistical functions such as means, medians, deviations and scatter plots. Optimization models such as linear programming are used to determine optimal resource allocation.
Figure: 28 Component of a Decision Support System
Types of Decision Support Systems

There are several ways to classify DSS applications. Not every DSS fits neatly into one category, but a mix of two or more architecture in one.

- Communication-driven DSS supports more than one person working on a shared task; examples include integrated tools like Microsoft's NetMeeting or Groove.
- Data-driven DSS or data-oriented DSS emphasizes access to and manipulation of a time series of internal organization data and, sometimes, external data.
- Document-driven DSS manages, retrieves, and manipulates unstructured information in a variety of electronic formats.
- Knowledge-driven DSS provides specialized problem-solving expertise stored as facts, rules, procedures, or in similar structures.
- Model-driven DSS emphasizes access to and manipulation of a statistical, optimization, or simulation model. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation; they are not necessarily data-intensive.

Benefits of DSS

1. Improves personal efficiency.
2. Expedites problem solving (speed up the progress of problems solving in an organization).
3. Facilitates interpersonal communication.
4. Promotes learning or training.
5. Increases organizational control.
6. Creates a competitive advantage over competition.
7. Helps automate the managerial processes.

**Model of DSS**

The model of a DSS may be represented as a block diagram as indicated below:-

![Proposed model for decision support system](image)

*Figure: 29 Proposed model for decision support system*
An Introduction to Expert Systems

An expert system is a knowledge-based information system; that is, it uses its knowledge about a specific area to act as an expert consultant to users. The components of an expert system are a knowledge base and software modules that perform inferences on the knowledge and offer answers to a user’s questions.

Expert systems provide answers to questions in a very specific problem area by making human-like inferences about knowledge contained in a specialized knowledge base. Expert systems can provide decision support to end users in the form of advice from an expert consultant in a specific problem area.

Expert systems are being used in many different fields, including medicine, engineering, the physical sciences, and business. For example, expert systems now help diagnose illnesses, search for minerals, analyze compounds, recommend repairs, and do financial planning. Expert systems can support either operations or management activities.

Expert Systems Structure

The components of an expert system include a knowledge base and software modules that perform inferences on the knowledge in the knowledge base and communicate answers to a user’s questions.

The knowledge base of an expert system contains Facts about a specific area, Heuristics (thumbs of rule) that express the reasoning procedures of an expert on the subject. There are many ways that knowledge is represented in expert systems:-
• **Case-based reasoning:** Representing knowledge in an expert system’s knowledge base in the form of cases.

• **Frame-based knowledge:** Knowledge represented in the form of a hierarchy or network of frames. A frame is a collection of knowledge about an entity consisting of a complex package of data values describing its attributes.

• **Object-based knowledge:** Knowledge represented as a network of objects. An object is a data element that includes both data and the methods or processes that act on those data.

• **Rule-based knowledge:** Knowledge represented in the form of rules and statements of fact. Rules are statements that typically take the form of a premise and a conclusion such as: IF (condition), Then (conclusion).

• **Software resources:** An expert system software package contains an inference engine and other programs for refining knowledge and communicating with users. The inference engine program processes the knowledge (such as rules and facts) related to a specific problem. It then makes associations and inferences resulting in recommended courses of action for a user. User interface programs for communicating with end-users are also needed, including an explanation program to explain the reasoning process to a user if requested.
Differences between DSS and ES

It is possible to integrate ES with DSS. There may be some components which may look similar in DSS and ES. But one should understand the differences between them. It then becomes clear as to how integration of ES with DSS can be realized.

- A DSS helps manager to take a decision whereas an ES acts as a decision maker or an advisor to the manager.
- A DSS is meant only for decision making whereas an ES provides expertise to the manager.
- The spectrum of complexity is high in DSS and low in ES since ES addresses issues related to specific areas only.
- DSS does not capability to reason whereas an ES has.
- A DSS cannot provide detailed explanation about the results whereas an ES can.

Hence by integrating the two it is possible the blend their advantages and derive the best out of the two.

Expert Systems Business Applications

Expert systems help diagnose illness, search minerals, analyze compounds, recommend repairs, and do financial planning. So from a strategic business point, expert systems can and are being used to improve every step of the product cycle of a business, from finding customers to shipping products to providing customer service. ES provides a cost reduced solution, consistent advice with low level of errors, solution to handle equipments without the interference of human. It provides a high degree of
reliability and faster response time. It helps to solve complex problem with in a small domain.

It is capable of analyzing the problem and can construct a business model appropriate to the characteristics of the application. Based on the model necessary objectives and constraints are identified. It identifies appropriate tools to solve the model. It uses the tools to solve the problem and also does the what–if analysis aimed at understanding the sensitivity of the model.

**Group Decisions Support System**

Group Decisions support system (GDSS) is an interactive computer-based system facilitating group decision-making processes to solve unstructured problems. In GDSS, members meet interactively together in specially designed rooms with online telecommunication and video conferencing facilities over Internet, extranet or private network. The decisions they arrived has group support. The decisions are largely rational, and unlikely bounded rationality–probably unbounded rationality since members have wide exposure, wide experiences and exploring all alternatives with intensity.

**Knowledge Management Systems**

Knowledge Management systems (KMS), Workers create, organize, and share important knowledge wherever and whenever it is needed. For example, many knowledge management systems rely on Internet and intranet Web sites, knowledge bases, and discussion forums as key technologies for gathering, storing, and disseminating business knowledge.
KMS systems deal with information (although Knowledge Management as a discipline may extend beyond the information centric aspect of any system) so they are a class of information system and may build on, or utilize other information sources.

The idea of a KM system is to enable employees to have ready access to the organization's documented base of facts, sources of information, and solutions. For example a typical claim justifying the creation of a KM system might run something like this: an engineer could know the metallurgical composition of an alloy that reduces sound in gear systems. Sharing this information organization wide can lead to more effective engine design and it could also lead to ideas for new or improved equipment. A Knowledge Management system could be any of the following:

1. Document based i.e. any technology that permits creation, management, sharing of formatted documents such as Lotus Notes, web, distributed databases etc.

2. Based on AI technologies which use a customized representation scheme to represent the problem domain.

3. Provide network maps of the organization showing the flow of communication between entities and individuals.
The Evolution of Support Systems

The first applications of computers did repetitive, large-volume, transactions-computing tasks. As the cost of computing decreased and computers’ capabilities increased, a new breed of information system, started to develop. These systems accessed, organized, summarized, and displayed information for supporting routine decision making in the functional areas. Office automation systems (OAS) such as airline reservation systems were developed to support office workers. Computers also were introduced in the manufacturing environment, with applications ranging from robotics to computer-aided design and manufacturing (CAD/CAM).

Additional increasing computing capabilities and reduced costs justified computerized support for a growing number of non-routine applications, and decision support systems were developed to provide computerized support for complex, non-routine decisions. The microcomputer revolution, which started around 1980, began the era of end-user computing, in which analysts, managers, and many other professionals can build and use systems on their own desktop computers. Decision support expanded in two directions: first, toward executives and then managers (executive support systems and enterprise information systems), and second, to people working in groups (group support systems).

Eventually, interest in programming computers to perform intelligent problem solving led to commercial applications known as intelligent support systems (ISSs). These include expert systems, which provide the stored knowledge of experts to non-experts, and a new breed of intelligent systems
with machine learning capabilities such as artificial neural networks and case-based reasoning that can learn from historical cases.

A major innovation in the evolution of support systems has been the development of data warehousing. A data warehouse is a database designed to support DSS, ESS, and other analytical and end-user activities. The use of data warehouses is a part of business intelligence, the gathering and use of large amounts of data for query or analysis by DSS, ESS, and intelligent systems.

The latest support system in organizations is mobile computing. Mobile computing supports mobile employees, those who are working with customers or business partners, at least part of the time, outside the physical boundaries of their companies. The mobile employees carry portable devices, which can access the Internet. These devices enable communication with organizations and other individuals via wireline or wireless networks.
Executive Support Systems

Senior managers use executive support systems (ESS) to help them make decisions. ESS serves the strategic level of the organization. They address non-routine decisions requiring judgment, evaluation, and insight because there is no agreed-on procedure for arriving at a solution.

Executive support systems (ESS's) are designed to incorporate data about external events, but they also draw summarized information from internal MIS and DSS. They filter, compress, and track critical data, displaying the data of greatest importance to senior managers.

ESS employs the most advanced graphics software and can present graphs and data from many sources. Often the information is delivered to senior executives through a portal, which uses a Web interface to present integrated personalized business content from a variety of sources.

Unlike the other types of information systems, ESS is not designed primarily to solve specific problems. Instead, ESS provides a generalized computing and communications capacity that can be applied to a changing array of problems. Although many DSS are designed to be highly analytical, ESS tends to make less use of analytical models.

ESS assist in answering include the following: In what business should we be? What are the competitors doing? What new acquisitions would protect us from cyclical business swings? Which units should we sell to raise cash for acquisitions? Figure (30) illustrates a model of an ESS. It consists of workstations with menus, interactive graphics, and communications capabilities that can be used to access historical and competitive data from internal corporate systems and external databases such as Dow Jones.
News/Retrieval or Standard & Poor’s. Because ESS are designed to be used by senior managers who often have little, if any, direct contact or experience with computer-based information systems, they incorporate easy-to-use graphic interfaces. This system pools data from diverse internal and external sources and makes them available to executives in an easy-to-use form.

![Figure 30: Model of a typical executive support system](image)

**Relationship of Systems to One Another**

Figure (31) illustrates how the systems serving different levels in the organization are related to one another. TPS are typically a major source of data for other systems, whereas ESS is primarily a recipient of data from lower-level systems. The other types of systems may exchange data with each other as well. Data may also be exchanged among systems serving different functional areas. For example, an order captured by a sales system may be
transmitted to a manufacturing system as a transaction for producing or delivering the product specified in the order or to a MIS for financial reporting.

FIGURE 31: Interrelationships among systems

The various types of systems in the organization have interdependencies. TPS are major producers of information that is required by the other systems, which, in turn, produce information for other systems. These different types of systems have been loosely coupled in most organizations. It is definitely advantageous to integrate these systems so that information can flow easily between different parts of the organization and provide management with an enterprise-wide view of how the organization is performing as a whole. But integration costs money, and integrating many different systems is extremely time consuming and complex. This is a major challenge for large organizations, which are typically saddled with hundreds, even thousands of different applications serving different levels and business functions. Each
organization must weigh its needs for integrating systems against the
difficulties of mounting a large-scale systems integration effort.

The Evolution of Support Systems

The first applications of computers did repetitive, large-volume, transactions-computing tasks. As the cost of computing decreased and computers’ capabilities increased, a new breed of information system, started to develop. These systems accessed, organized, summarized, and displayed information for supporting routine decision making in the functional areas. Office automation systems (OAS) such as airline reservation systems were developed to support office workers. Computers also were introduced in the manufacturing environment, with applications ranging from robotics to computer-aided design and manufacturing (CAD/CAM).

Additional increasing computing capabilities and reduced costs justified computerized support for a growing number of non-routine applications, and decision support systems were developed to provide computerized support for complex, non-routine decisions. The microcomputer revolution, which started around 1980, began the era of end-user computing, in which analysts, managers, and many other professionals can build and use systems on their own desktop computers. Decision support expanded in two directions: first, toward executives and then managers (executive support systems and enterprise information systems), and second, to people working in groups (group support systems).

Eventually, interest in programming computers to perform intelligent problem solving led to commercial applications known as intelligent support
systems (ISSs). These include expert systems, which provide the stored knowledge of experts to non-experts, and a new breed of intelligent systems with machine learning capabilities such as artificial neural networks and case-based reasoning that can learn from historical cases.

A major innovation in the evolution of support systems has been the development of data warehousing. A data warehouse is a database designed to support DSS, ESS, and other analytical and end-user activities. The use of data warehouses is a part of business intelligence, the gathering and use of large amounts of data for query or analysis by DSS, ESS, and intelligent systems.

The latest support system in organizations is mobile computing. Mobile computing supports mobile employees, those who are working with customers or business partners, at least part of the time, outside the physical boundaries of their companies. The mobile employees carry portable devices, which can access the Internet. These devices enable communication with organizations and other individuals via wireline or wireless networks.

![Figure 32: Interrelated support systems.](image)
<table>
<thead>
<tr>
<th>Systems</th>
<th>Employees Supported</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction processing system (TPS)</td>
<td>All employees</td>
<td>Processes an organization’s basic business transactions (e.g., purchasing, billing, and payroll).</td>
</tr>
<tr>
<td>Management information system (MIS)</td>
<td>All employees</td>
<td>Provides routine information for planning, organizing, and controlling operations in functional areas.</td>
</tr>
<tr>
<td>Office automation system (OAS)</td>
<td>Office workers</td>
<td>Increases productivity of office workers; includes word processing.</td>
</tr>
<tr>
<td>CAD/CAM</td>
<td>Engineers, drafts people</td>
<td>Allows engineers to design and test prototypes; transfers specifications to manufacturing facilities.</td>
</tr>
<tr>
<td>Document management system (DMS)</td>
<td>Office workers</td>
<td>Automates flow of electronic documents.</td>
</tr>
<tr>
<td>Decision support system (DSS)</td>
<td>Decision makers, managers</td>
<td>Combines models and data to solve Semi-structured problems with extensive user involvement.</td>
</tr>
<tr>
<td>Executive support system (ESS)</td>
<td>Executives, senior managers</td>
<td>Supports decisions of top managers.</td>
</tr>
<tr>
<td>Group support system (GSS)</td>
<td>People working in groups</td>
<td>Supports working processes of groups of people (including those in different locations).</td>
</tr>
<tr>
<td>Expert system (ES)</td>
<td>Knowledge workers, non-experts</td>
<td>Provides stored knowledge of experts to non-experts and decision recommendations based on built-in expertise.</td>
</tr>
<tr>
<td>Knowledge work system (KWS)</td>
<td>Managers, knowledge workers</td>
<td>Supports the gathering, organizing, and use of an organization’s knowledge.</td>
</tr>
<tr>
<td>Data warehouse</td>
<td>Managers, knowledge workers</td>
<td>Stores huge amounts of data that can be easily accessed and manipulated for decision support.</td>
</tr>
<tr>
<td>Business intelligence</td>
<td>Decision makers, managers</td>
<td>Gathers and uses large amounts of data for analysis by DSS, ESS and intelligent systems.</td>
</tr>
<tr>
<td>Mobile computing systems</td>
<td>Mobile employees</td>
<td>Support employees who work with customers or business partners outside the physical boundaries of the organization.</td>
</tr>
</tbody>
</table>