1.1 EFFECTIVE AND TIMELY DECISIONS

What is Business intelligence?

- Business intelligence may be defined as a set of mathematical models and analysis methodologies that exploit the available data to generate information and knowledge useful for complex decision-making processes.
- In general terms the problems entailed in business intelligence, highlighting the interconnections with other disciplines and identifying the primary components typical of respective environment.
- The main purpose of business intelligence systems is to provide knowledge workers with tools and methodologies that allow them to make effective and timely decisions.
- In complex organizations, public or private, decisions are made on a continual basis which involve people and roles at various hierarchical levels.
- The ability of these knowledge workers to make decisions, both as individuals and as a community, is one of the primary factors that influence the performance and competitive strength of a given organization.
- Most knowledge workers reach their decisions primarily using easy and intuitive methodologies, which take into account specific elements such as experience, knowledge of the application domain and the available information.
- In Decision-Making processes within today's organizations are often too complex and dynamic to be effectively dealt with through an intuitive approach, and require instead a more rigorous attitude based on analytical methodologies and mathematical models.

Effective decisions

1. The application of rigorous analytical methods allows decision makers to rely on information and knowledge which are more dependable.
2. As a result, they are able to make better decisions and devise action plans that allow their objectives to be reached in a more effective way.
3. Indeed, turning to formal analytical methods forces decision makers to explicitly describe both the criteria for evaluating alternative choices and the mechanisms regulating the problem under investigation.
4. Furthermore, the ensuing in-depth examination and thought lead to a deeper awareness and comprehension of the underlying logic of the decision-making process

Timely decisions

1. Enterprises operate in economic environments characterized by growing levels of competition and high dynamism.
2. As a consequence, the ability to rapidly react to the actions of competitors and to new market conditions is a critical factor in the success or even the survival of a company.
3. Decision makers ask themselves a series of questions and develop the corresponding analysis. Hence, they examine and compare several options, selecting among them the best decision, given the conditions at hand.

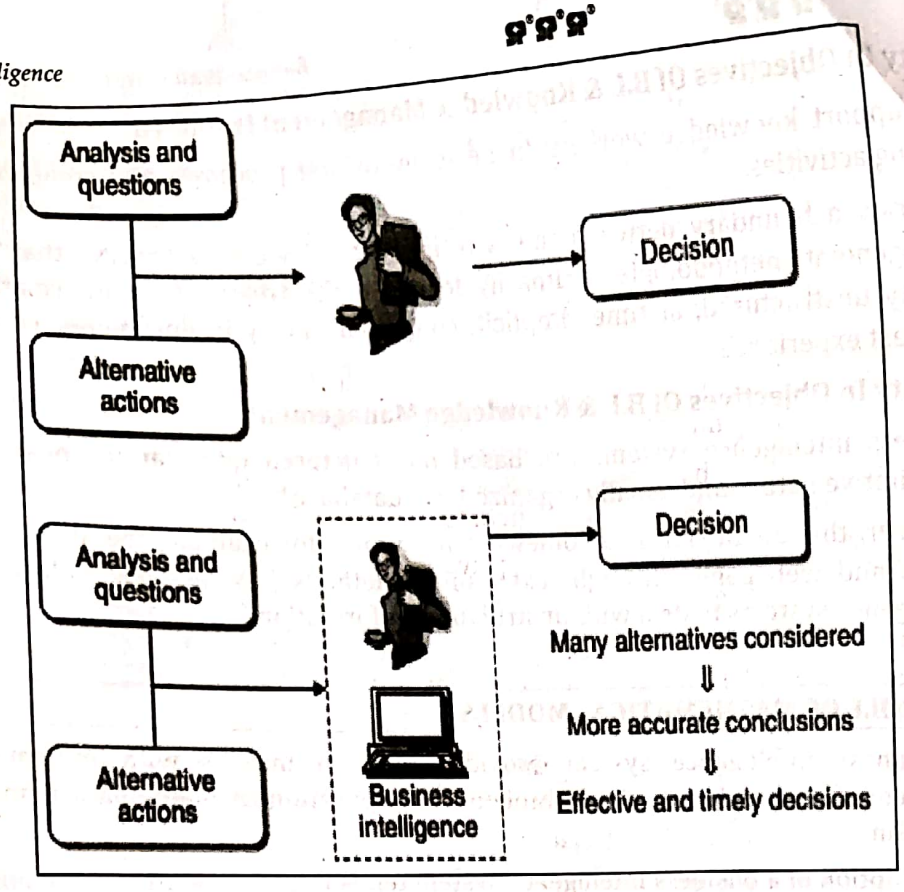

Fig.: 1.1 shows benefits of Intelligence System.

1.2 DATA, INFORMATION AND KNOWLEDGE

Data

1. Generally, data represent a structured codification of single primary entities, as well as of transactions involving two or more primary entities.
2. For example, for a retailer data refer to primary entities such as customers, points of sale and items, while sales receipts represent the commercial transactions.

Information

1. Information is the outcome of extraction and processing activities carried out on data, and it appears meaningful for those who receive it in a specific domain.
2. For example, to the sales manager of a retail company, the proportion of sales receipts in the amount of over 100 units per week, or the number of customers holding a loyalty card who have reduced by more than 50% the monthly amount spent in the last three months, represent meaningful pieces of information that can be extracted from raw stored data.

Knowledge

1. Information is transformed into knowledge when it is used to make decisions and develop the corresponding actions.
2. Therefore, we can think of knowledge as consisting of information put to work into a specific domain, enhanced by the experience and competence of decision makers in tackling and solving complex problems.
3. The activity of providing support to knowledge workers through the integration of decision-making processes and enabling information technologies is usually referred to as knowledge management.

Similarity In Objectives Of B.I. & Knowledge Management Is Due To

1. To support knowledge workers in decision-making processes and complex problem solving activities.
2. To draw a boundary between the two approaches, we may observe that knowledge management methodologies primarily focus on the treatment of information that is usually unstructured, at times implicit, contained mostly in documents, conversations and past experience.

Disimilarity In Objectives Of B.I. & Knowledge Management

1. Business intelligence systems are based on structured information, most often of quantitative nature and usually organized in a database.
2. However, this distinction is a somewhat fuzzy one: for example, the ability to analyze emails and web pages through text mining methods progressively induces business intelligence systems to deal with unstructured information.

1.3 THE ROLE OF MATHEMATICAL MODELS

- A business intelligence system provides decision makers with information and knowledge extracted from data, through the application of mathematical models and algorithms.
- The adoption of a business intelligence system tends to promote a scientific and rational approach to the management of enterprises and complex organizations.
- The rational approach typical of a business intelligence analysis can be summarized schematically in the following main characteristics.
- First, the objectives of the analysis are identified and the performance indicators that will be used to evaluate alternative options are defined.
- Mathematical models are then developed by exploiting the relationships among system control variables, parameters and evaluation metrics.
- Finally, what-if analyses are carried out to evaluate the effects on the performance determined by variations in the control variables and changes in the parameters.
- The development of an abstract model forces decision makers to focus on the main features of the analyzed domain, thus inducing a deeper understanding of the phenomenon under investigation.
- The knowledge about the domain acquired when building a mathematical model can be more easily transferred in the long run to other individuals within the same organization, thus allowing a sharper preservation of knowledge in comparison to empirical decision-making processes.
- Finally, a mathematical model developed for a specific decision-making task is so general and flexible that in most cases it can be applied to other ensuing situations to solve problems of similar type.

1.4 BUSINESS INTELLIGENCE ARCHITECTURES

The architecture of a business intelligence system, depicted in Figure 1.2, includes three major components.

1. Data sources
2. Data warehouses and data marts
3. Business intelligence methodologies

1. **Data sources**
   - In a first stage, it is necessary to gather and integrate the data stored in the various primary and secondary sources, which are heterogeneous in origin and type.
   - The sources consist for the most part of data belonging to operational systems, but may also include unstructured documents, such as emails and data received from external providers

2. **Data warehouses and data marts**
   - Using extraction and transformation tools known as extract, transform, load (ETL), the data originating from the different sources are stored in databases intended to support business intelligence analyses.

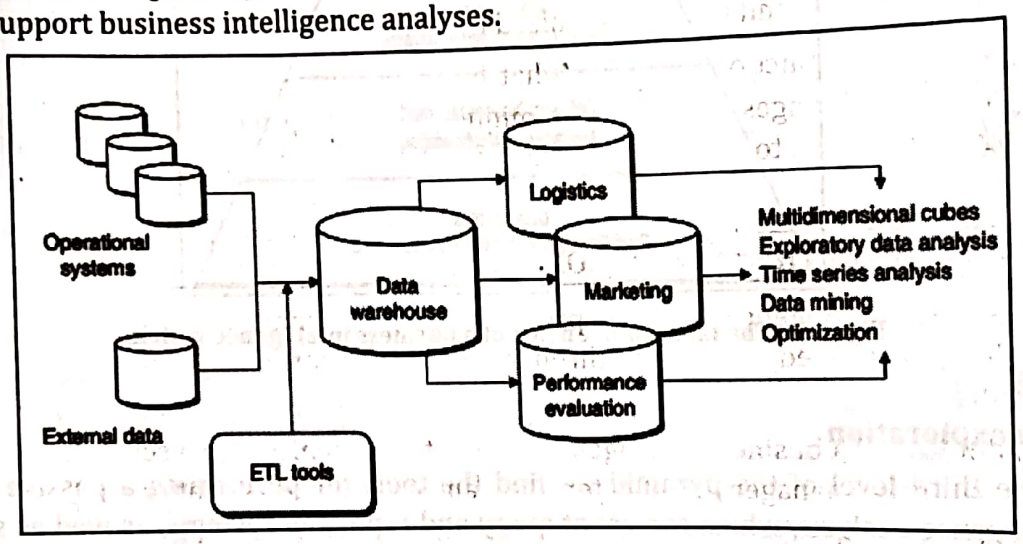

Fig.: 1.2 A typical business intelligence architecture

3. **Business intelligence methodologies**
   - Data are finally extracted and used to feed mathematical models and analysis methodologies intended to support decision makers.
   - In a business intelligence system, several decision support applications may be implemented based on following:

- Multidimensional cube analysis;
- Exploratory data analysis;
- Time series analysis;
- Inductive learning models for data mining;
- Optimization models.
- The pyramid in Figure 1.3 shows the building blocks of a business intelligence system.

So far, we have seen the components of the first two levels when discussing Figure 1.2. We now turn to the description of the upper tiers.

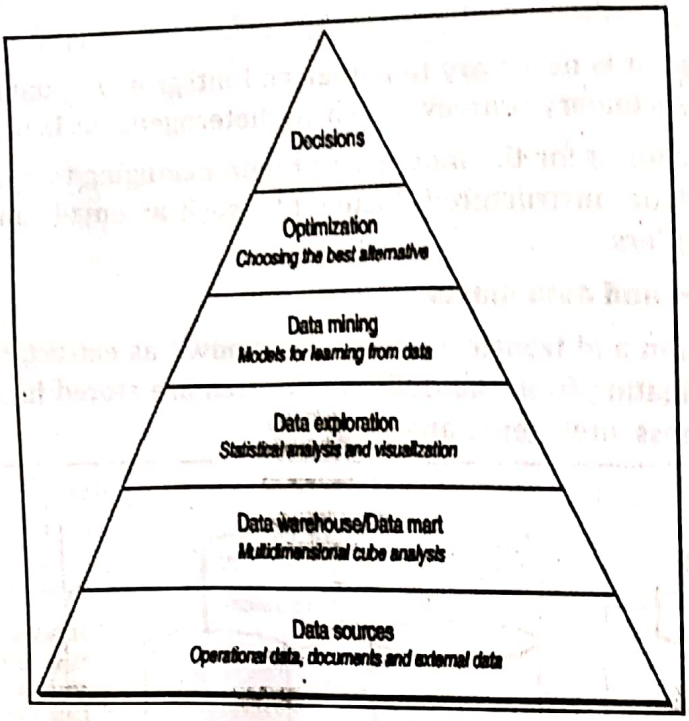

Fig.: 1.3 : The main components of a business intelligence system

4. Data exploration

- At the third level of the pyramid we find the tools for performing a passive business intelligence analysis, which consist of query and reporting systems, as well as statistical methods.
- These are referred to as passive methodologies because decision makers are requested to generate prior hypotheses or define data extraction criteria, and then use the analysis tools to find answers and confirm their original insight.

5. Data mining

- The fourth level includes active business intelligence methodologies, whose purpose is the extraction of information and knowledge from data.
- These include mathematical models for pattern recognition, machine learning and data mining techniques.

6. Optimization

- By moving up one level in the pyramid we find optimization models that allow us to determine the best solution out of a set of alternative actions, which is usually fairly extensive and sometimes even infinite.

7. Decisions

- Finally, the top of the pyramid corresponds to the choice and the actual adoption of a specific decision, and in some way represents the natural conclusion of the decision-making process.

Cycle Of A Business Intelligence Analysis

- Each business intelligence analysis follows its own path according to the application domain, the personal attitude of the decision makers and the available analytical methodologies.
- Example : Figure 1.4 shows cycle of B.I. in logistics.

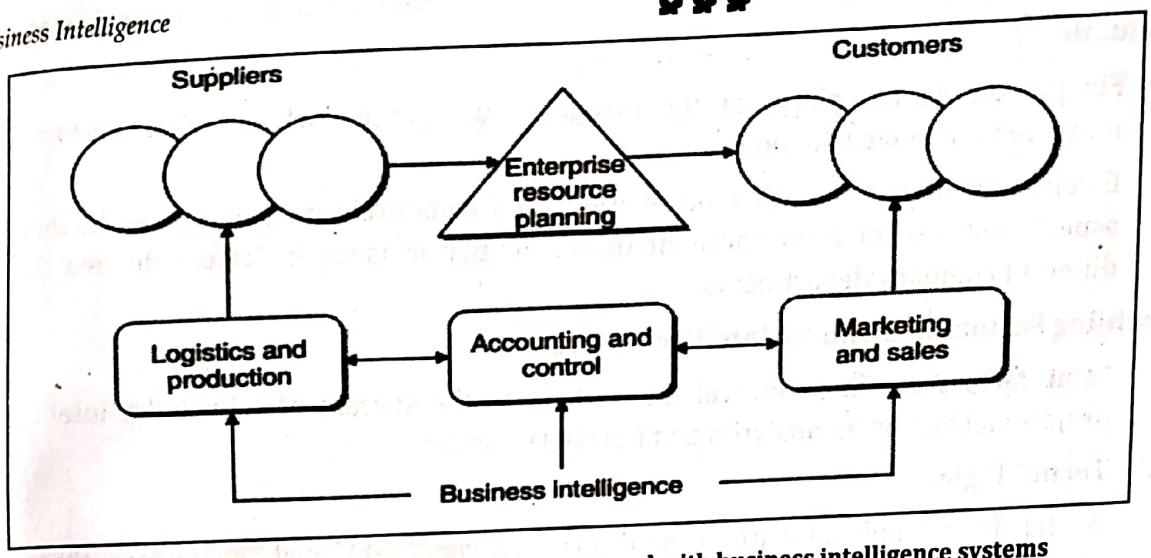

Fig.: 1.4 : Departments of an enterprise concerned with business intelligence systems

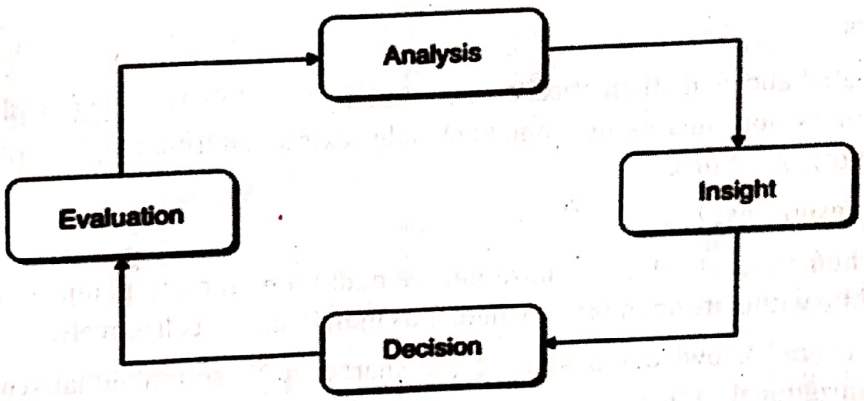

Fig.: 1.5 : Cycle of a business intelligence analysis

Analysis

- During the analysis phase, it is necessary to recognize and accurately spell out the problem at hand.
- Decision makers must then create a mental representation of the phenomenon being analyzed, by identifying the critical factors that are perceived as the most relevant.

Insight

- The second phase allows decision makers to better and more deeply understand the problem at hand, often at a causal level.
- For instance, if the analysis carried out in the first phase shows that a large number of customers are discontinuing an insurance policy upon yearly expiration, in the second phase it will be necessary to identify the profile and characteristics shared by such customers.

Decision

- During the third phase, knowledge obtained as a result of the insight phase is converted into decisions and subsequently into actions.
- The availability of business intelligence methodologies allows the analysis and insight phases to be executed more rapidly so that more effective and timely decisions can be made that better suit the strategic priorities of a given organization.
- This leads to an overall reduction in the execution time of the analysis–decision–action–revision cycle, and thus to a decision-making process of better quality.

Evaluation

- Finally, the fourth phase of the business intelligence cycle involves performance measurement and evaluation.
- Extensive metrics should then be devised that are not exclusively limited to the financial aspects but also take into account the major performance indicators defined for the different company departments.

Enabling Factors in Business Intelligence Projects

- Some factors are more critical than others to the success of a business intelligence project : technologies, analytics and human resources.

1. Technologies

- Hardware and software technologies are significant enabling factors that have facilitated the development of business intelligence systems within enterprises and complex organizations.

2. Analytics

- As stated above, mathematical models and analytical methodologies play a key role in information enhancement and knowledge extraction from the data available inside most organizations.

3. Human resources

- The human assets of an organization are built up by the competencies of those who operate within its boundaries, whether as individuals or collectively.
- The overall knowledge possessed and shared by these individuals constitutes the organizational culture.
- The ability of knowledge workers to acquire information and then translate it into practical actions is one of the major assets of any organization, and has a major impact on the quality of the decision-making process.

Development of A Business Intelligence System

- The development of a business intelligence system can be assimilated to a project, with a specific final objective, expected development times and costs, and the usage and coordination of the resources needed to perform planned activities.
- Figure 1.6 shows the typical development cycle of a business intelligence architecture.

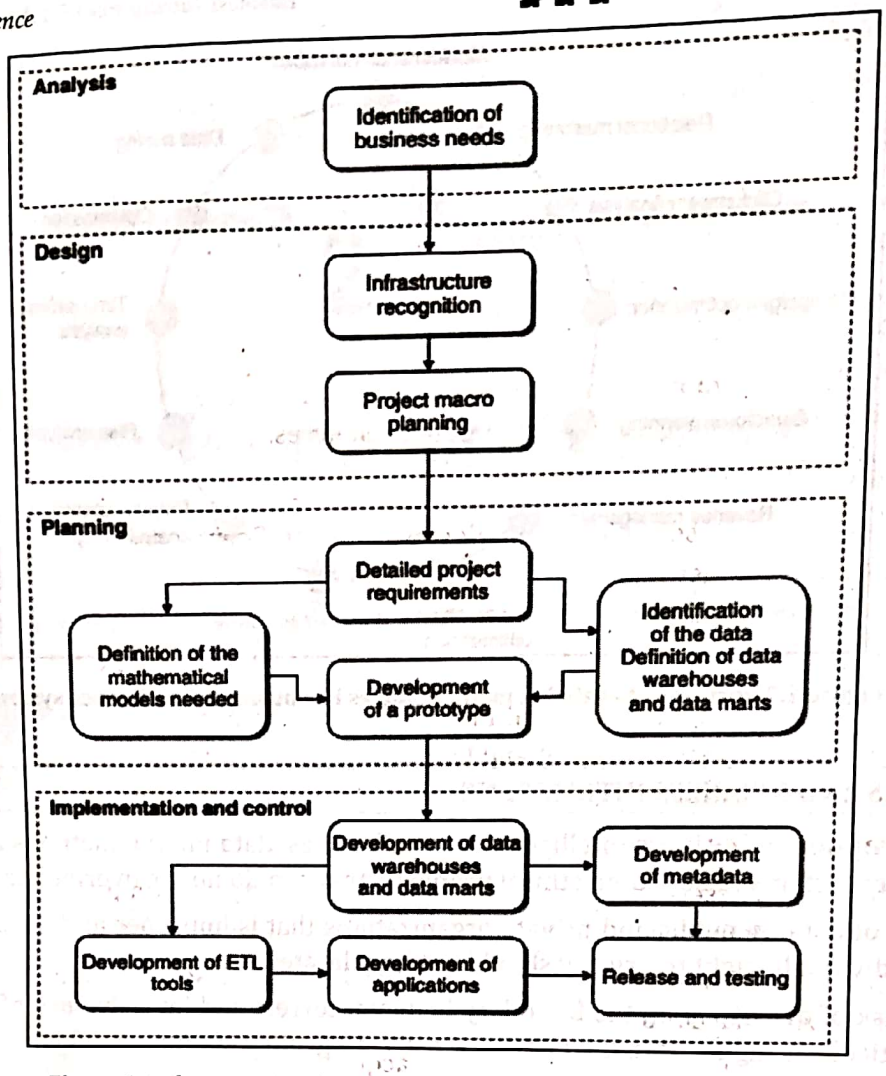

Figure 1.6 Phases in the development of a business intelligence system

Analysis

- During the first phase, the needs of the organization relative to the development of a business intelligence system should be carefully identified.
- This preliminary phase is generally conducted through a series of interviews of knowledge workers performing different roles and activities within the organization.

Design

- The second phase includes two sub-phases and is aimed at deriving a provisional plan of the overall architecture, taking into account any development in the near future and the evolution of the system in the mid term.

Planning

- The planning stage includes a sub-phase where the functions of the business intelligence system are defined and described in greater detail. Subsequently, existing data as well as other data that might be retrieved externally are assessed.

Implementation and control

- The last phase consists of five main sub-phases. First, the data warehouse and each specific data mart are developed.
- These represent the information infrastructures that will feed the business intelligence system.
- Figure 1.7 provides an overview of the main methodologies that may be included in a business intelligence system.

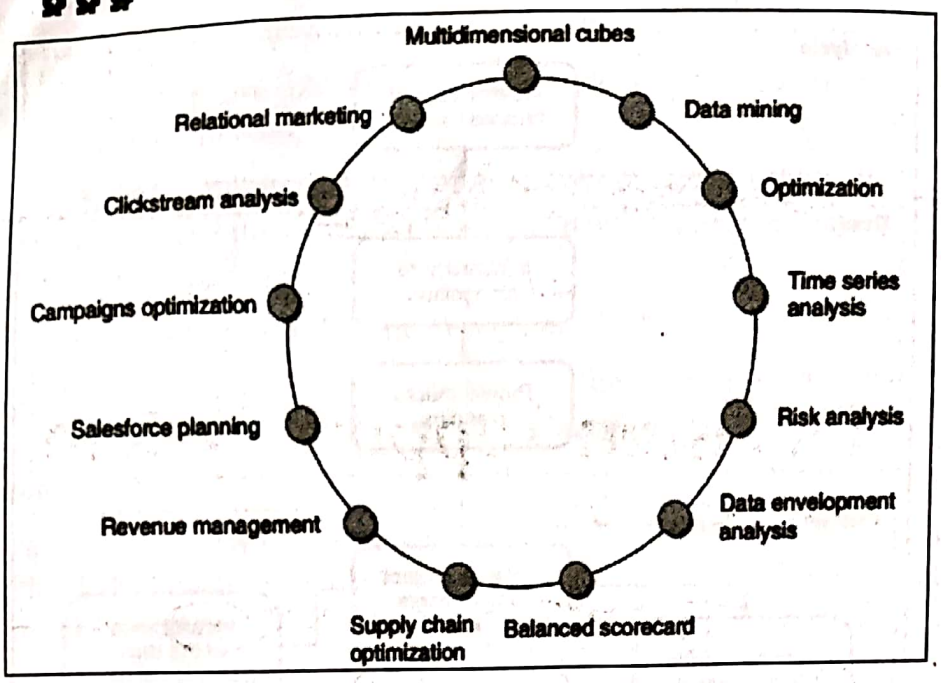

Figure 1.7 Portfolio of available methodologies in a business intelligence system

1.5 ETHICS AND BUSINESS INTELLIGENCE

- The adoption of business intelligence methodologies, data mining methods and decision support systems raises some ethical problems that should not be overlooked.
- Usage of data by public and private organizations that is improper and does not respect the individuals' right to privacy should not be tolerated.
- The risk of overstepping the boundary between correct and intrusive use of information is particularly high within the relational marketing and web mining fields.
- Respect for the right to privacy is not the only ethical issue concerning the use of business intelligence systems.
- There is a diversity of opinion on whether a company should pursue the short-term maximization of profits, acting exclusively in the interest of shareholders, or should instead adopt an approach that takes into account the social consequences of its decisions.

QUESTIONS BANK

1. What is meant Business Intelligence? Explain importance of Effective and Timely Decision in Business Intelligence.
2. Explain the difference between Data, Information, Knowledge and wisdom w.r.t. Business Intelligence.
3. Compare and contrast between Business Intelligence and knowledge Management.
4. Explain role of mathematical model in Business Intelligence
5. Explain in brief with diagram Business Intelligence Architecture.
6. Explain major components of Business Intelligence
7. Write a short note on cycle of Business Intelligence Analysis.
8. Explain in detail Enabling Factors In Business Intelligence Projects.
9. Explain different Phases of the development of a business intelligence system.
10. Explain importance of Ethics in Business Intelligence.

What Is Decision Support Systems?

- A decision support system (DSS) is an interactive computer-based application that combines data and mathematical models to help decision makers solve complex problems faced in managing the public and private enterprises and organizations.

2.1 DEFINITION OF SYSTEM

- The term system is often used in everyday language: For instance, we refer to the solar system, the nervous system or the justice system.
- The entities that we intuitively denominate systems share a common characteristic, which we will adopt as an abstract definition of the notion of system: each of them is made up of a set of components that are in some way connected to each other so as to provide a single collective result and a common purpose.

How System can be Characterized?

- Every system is characterized by boundaries that separate its internal components from the external environment.
- A system is said to be **open** if its boundaries can be crossed in both directions by flows of materials and information, When such flows are lacking, the system is said to be **closed.**
- In general terms, any given system receives specific input flows, carries out an internal transformation process and generates observable output flows.
- Figure 2.1 shows the structure that we will use as a reference to describe the concept of system

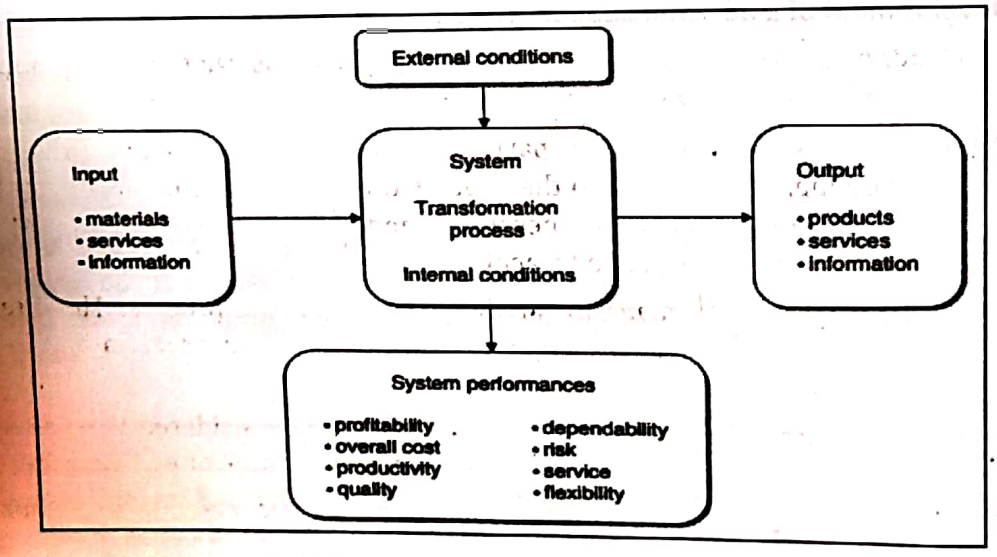

Fig.: 2.1 Abstract representation of a system

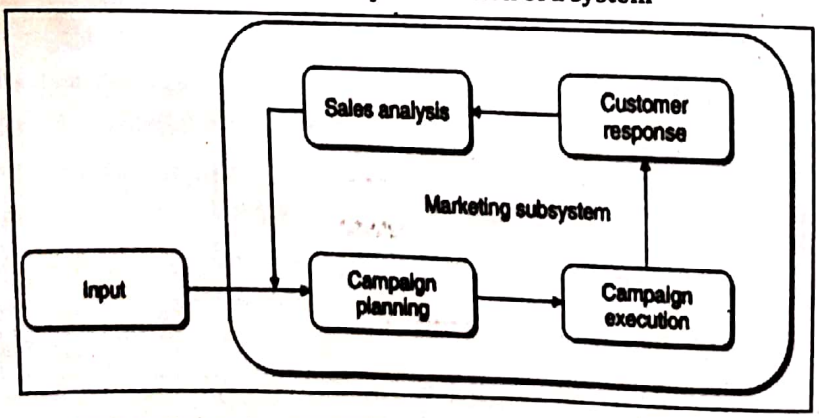

Fig.: 2.2 : A closed cycle marketing system with feedback effects

Evaluation Metrics of System

- It is often necessary to assess the performance of a system.
- For this purpose, it is appropriate to categorize the evaluation metrics into two main classes: effectiveness and efficiency.

Effectiveness

- Effectiveness measurements express the level of conformity of a given system to the objectives for which it was designed.
- The associated performance indicators are therefore linked to the system output flows, such as production volumes, weekly sales and yield per share.

Efficiency

- Efficiency measurements highlight the relationship between input flows used by the system and the corresponding output flows.
- Efficiency measurements are therefore associated with the quality of the transformation process.

2.2 REPRESENTATION OF THE DECISION-MAKING PROCESS

- In order to build effective DSSs, we first need to describe in general terms how a decision-making process is articulated as follows:

1. **Rationality and problem solving**
   - A decision is a choice from multiple alternatives, usually made with a fair degree of rationality.
   - Each individual faces on a continual basis decisions that can be more or less important, both in their personal and professional life.
   - The decision-making process is part of a broader subject usually referred to as problem solving, which refers to the process through which individuals try to bridge the gap between the current operating conditions of a system (as is) and the supposedly better conditions to be achieved in the future (to be).
   - Figure 2.3 outlines the structure of the problem-solving process. The alternatives represent the possible actions aimed at solving the given problem and helping to achieve the planned objective.
   - In some instances, the number of alternatives being considered may be small. In other instances, the number of alternatives can be very large or even infinite.
   - For example, the development of the annual logistic plan of a manufacturing company.

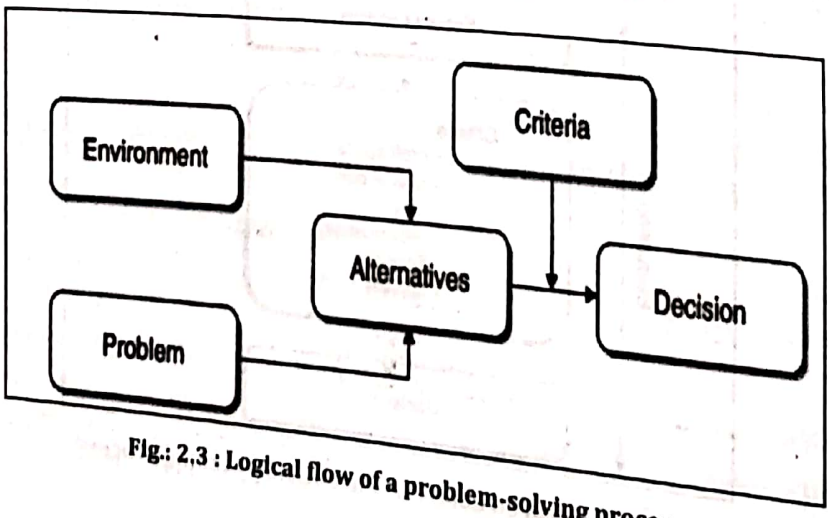

Fig.: 2.3 : Logical flow of a problem-solving process

- Criteria are the measurements of effectiveness of the various alternatives and correspond to the different kinds of system performance.
- Factors influencing a rational choice in taking Decision are as follows :

1. Economic

Economic factors are the most influential in decision-making processes, and are often aimed at the minimization of costs or the maximization of profits. For example, an annual logistic plan.

2. Technical

Options that are not technically feasible must be discarded.

For instance, a production plan that exceeds the maximum capacity of a plant cannot be regarded as a feasible option.

3. Legal

Legal rationality implies that before adopting any choice the decision makers should verify whether it is compatible with the legislation in force within the application domain.

4. Ethical

Besides being compliant with the law, a decision should abide by the ethical principles and social rules of the community to which the system belongs.

5. Procedural

A decision may be considered ideal from an economic, legal and social standpoint, but it may be unworkable due to cultural limitations of the organization in terms of prevailing procedures and common practice.

Political

The decision maker must also assess the political consequences of a specific decision among individuals, departments and organizations.

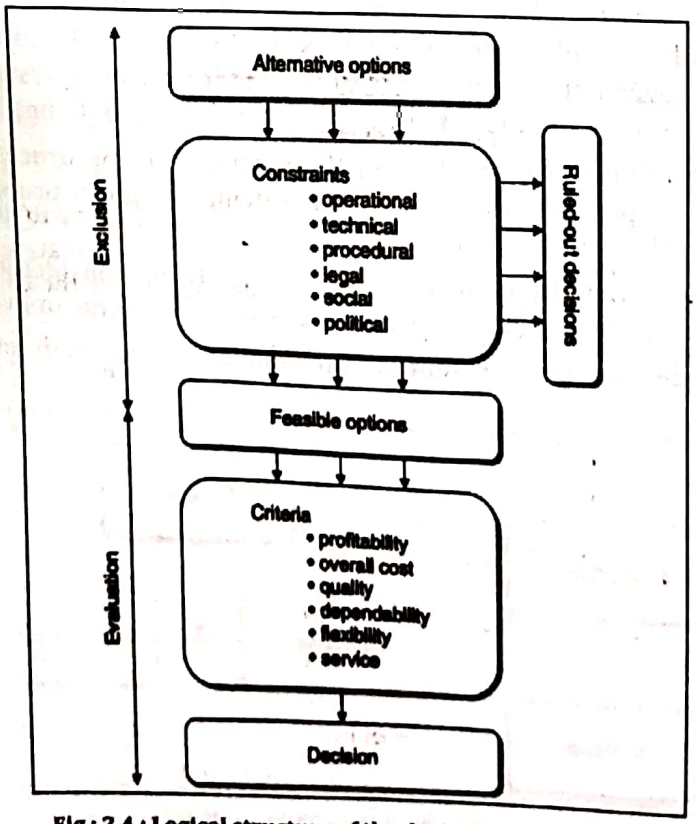

Fig.: 2.4 : Logical structure of the decision-making process

The Decision-making Process model includes five phases, termed intelligence, design and choice (Refer Figure 2.5):

1. **Intelligence**
   - In the intelligence phase the task of the decision maker is to identify, circumscribe and explicitly define the problem that emerges in the system under study.
   - The analysis of the context and all the available information may allow decision makers to quickly grasp the signals and symptoms pointing to a corrective action to improve the system performance.
2. **Design**
   - In the design phase actions aimed at solving the identified problem should be developed and planned.
   - At this level, the experience and creativity of the decision makers play a critical role, as they are asked to devise viable solutions that ultimately allow the intended purpose to be achieved.

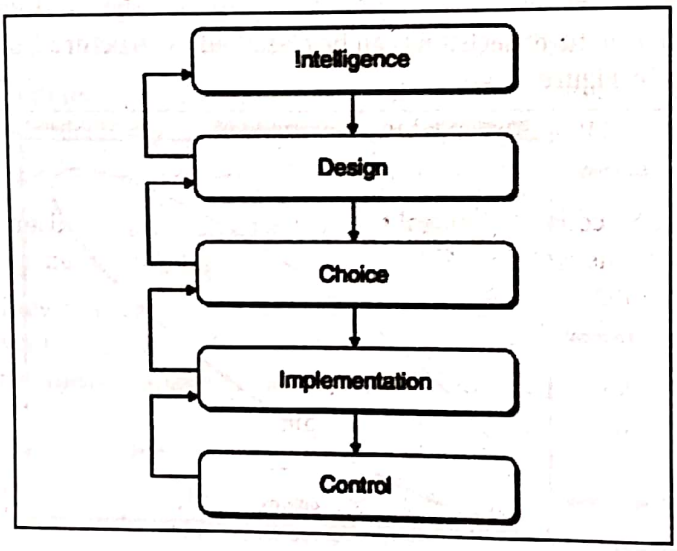

Fig.: 2.5 : Phases of the decision-making process

3. **Choice**

Once the alternative actions have been identified, it is necessary to evaluate them on the basis of the performance criteria deemed significant. Mathematical models and the corresponding solution methods usually play a valuable role during the choice phase.

4. **Implementation**

When the best alternative has been selected by the decision maker, it is transformed into actions by means of an implementation plan.

5. **Control**

Once the action has been implemented, it is finally necessary to verify and check that the original expectations have been satisfied and the effects of the action match the original intentions.

Summarization of Aspects To Characterize A Decision Making Process:

The most relevant aspects characterizing a decision-making process can be briefly summarized as follows.

1. Decisions are often devised by a group of individuals instead of a single decision maker.
2. The number of alternative actions may be very high, and sometimes unlimited.
3. The effects of a given decision usually appear later, not immediately.

4. The decisions made within a public or private enterprise or organization are often interconnected and determine broad effects.
5. During the decision-making process knowledge workers are asked to access data and information, and work on them based on a conceptual and analytical framework.
6. Feedback plays an important role in providing information and knowledge for future decision-making processes within a given organization.
7. In most instances, the decision-making process has multiple goals, with different performance indicators, that might also be in conflict with one another.
8. Experiments carried out in a real-world system, according to a trial-anderror scheme, are too costly and risky to be of practical use for decision making.
9. The dynamics in which an enterprise operates, strongly affected by the pressure of a competitive environment, imply that knowledge workers need to address situations and make decisions quickly and in a timely fashion.

Types of Decisions

- According to their nature, decisions can be classified as structured, unstructured or semi-structured. (Refer Figure. 2.6)

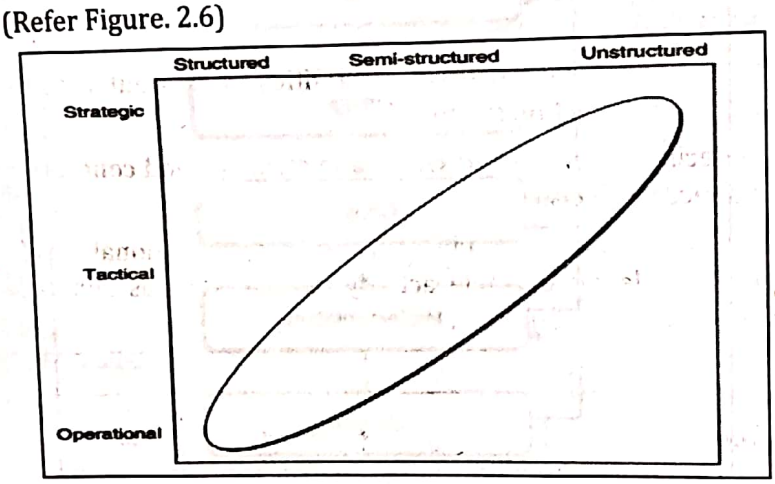

Fig.: 2.6 : A taxonomy of decisions

1. Structured decisions

- A decision is structured if it is based on a well-defined and recurring decision-making procedure.
- In most cases structured decisions can be traced back to an algorithm, which may be more or less explicit for decision makers, and are therefore better suited for automation.

2. Unstructured decisions

- A decision is said to be unstructured if the three phases of intelligence, design and choice are also unstructured.
- This means that for each phase there is at least one element in the system (input flows, output flows and the transformation processes) that cannot be described in detail and reduced to a predefined sequence of steps

3. Semi-structured decisions

- A decision is semi-structured when some phases are structured and others are not.
- Most decisions faced by knowledge workers in managing public or private enterprises or organizations are semi-structured.
- The nature of a decision process depends on many factors, including

A. The **characteristics** of the organization within which the system is placed;

B. The **subjective attitudes** of the decision makers;

C. The **availability** of appropriate problem-solving methodologies; and the **availability** of effective decision support tools.

4. Strategic decisions

- Decisions are strategic when they affect the entire organization or at least a substantial part of it for a long period of time.
- Strategic decisions strongly influence the general objectives and policies of an enterprise.

5. Tactical decisions

- Tactical decisions affect only parts of an enterprise and are usually restricted to a single department. The time span is limited to a medium-term horizon, typically up to a year.
- Tactical decisions place themselves within the context determined by strategic decisions.

6. Operational decisions:

- Operational decisions refer to specific activities carried out within an organization and have a modest impact on the future.
- Operational decisions are framed within the elements and conditions determined by strategic and tactical decisions.
- Therefore, they are usually made at a lower organizational level, by knowledge workers responsible for a single activity or task such as sub-department heads, workshop foremen, back-office heads.

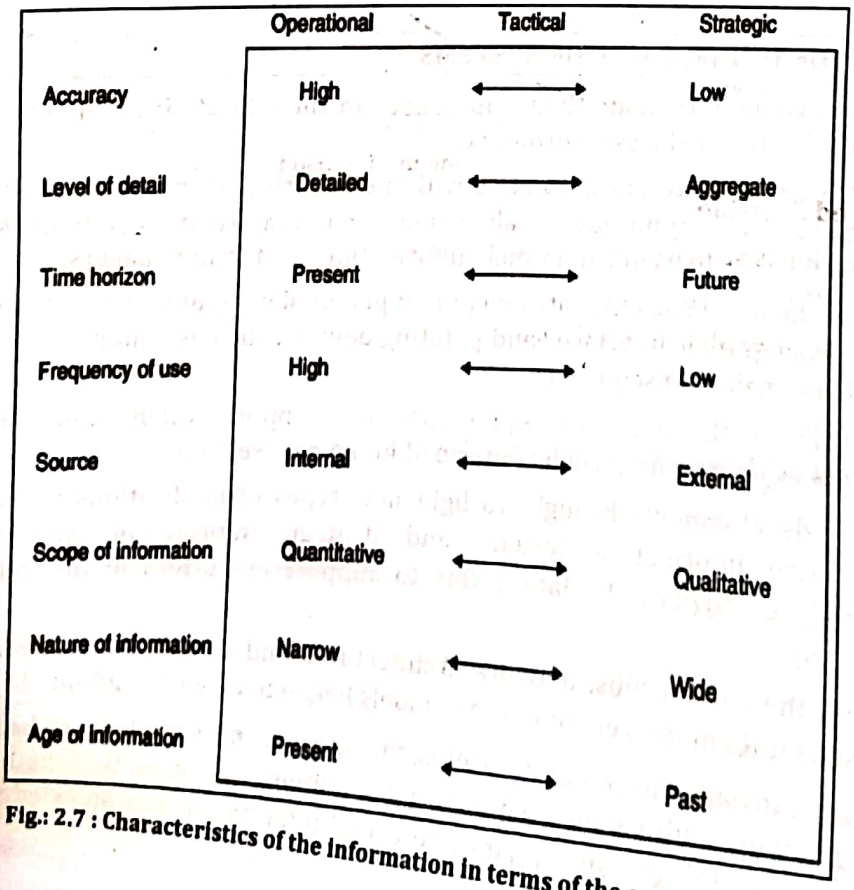

Fig.: 2.7 : Characteristics of the information in terms of the scope of decision

Approaches To The Decision-making Process

- A preliminary distinction should be made between a rational approach and a political-organizational approach.

1. **Rational approach**
   - ❖ When a rational approach is followed, a decision maker considers major factors, such as economic, technical, legal, ethical, procedural and political, also establishing the criteria of evaluation so as to assess different options and then select the best decision.
2. **Political-organizational approach**
   - When a political-organizational approach is pursued, a decision maker proceeds in a more instinctual and less systematic way.
3. **Absolute rationality**
   - The term 'absolute rationality' refers to a decision-making process for which multiple performance indicators can be reduced to a single criterion, which therefore naturally lends itself to an optimization model.
4. **Bounded rationality**
   - ❖ Bounded rationality occurs whenever it is not possible to meaningfully reduce multiple criteria into a single objective, so that the decision maker considers an option to be satisfactory when the corresponding performance indicators fall above or below prefixed threshold values.
   - ❖ For instance, a production plan is acceptable if its cost is sufficiently low, the stock quantities are within a given threshold, and the service time is below customers expectations.

2.3 EVOLUTION OF INFORMATION SYSTEMS

- Digital computers made their appearance in the late 1940s, and soon began to be applied in the business environment.
- In the 1970s there began to arise within enterprises increasingly complex needs to devise software applications, called management information systems (MIS), in order to ease access to useful and timely information for decision makers.
- From the late 1980s the introduction of personal computers with operating systems featuring graphic interfaces and pointing devices, such as a mouse or an optical pen, had two major consequences.
- Meanwhile, the initial concept of decision support system was also introduced, whose exact meaning will be described in the next section.
- Later developments brought to light new types of applications and architectures: executive information systems and strategic information systems were first introduced toward the late 1980s to support executives in the decision-making process.
- From the early 1990s, network architectures and distributed information systems based on client–server computing models began to be widely adopted.
- Finally, toward the end of the 1990s, the term business intelligence began to be used to generally address the architecture containing DSSs, analytical methodologies and models used to transform data into useful information and knowledge for decision makers,

- Since the late 1980s, a decision support system has been defined as an interactive computer system helping decision makers to combine data and models to solve semi-structured and unstructured problems.
- This definition entails the three main elements of a DSS shown in Figure 2.8: a database, a repository of mathematical models and a module for handling the dialogue between the system and the users.

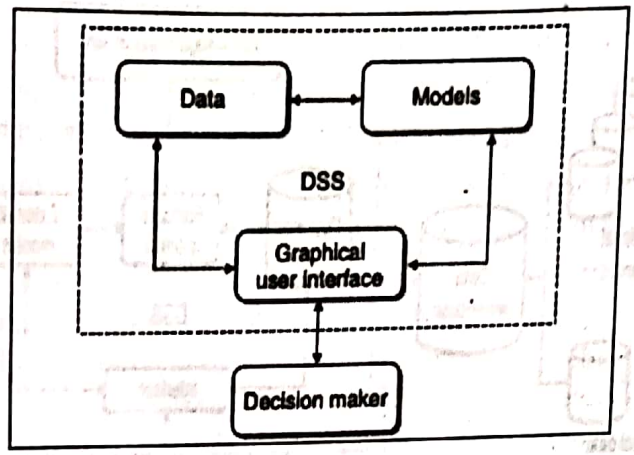

Fig.: 2.8 : Structure of a decision support system

2.4 DEFINITION OF DECISION SUPPORT SYSTEM

It is worth highlighting the relevant features of a DSS as follows:

Effectiveness

Decision support systems should help knowledge workers to reach more effective decisions.

Mathematical models

In order to achieve more effective decisions, a DSS makes use of mathematical models, borrowed from disciplines such as operations research and statistics, which are applied to the data contained in data warehouses and data marts.

Integration in the decision-making process

A DSS should provide help for different kinds of knowledge workers, within the same application domain, particularly in respect of semi-structured and unstructured decision processes, both of an individual and a collective nature.

Organizational role

In many situations the users of a DSS operate at different hierarchical levels within an enterprise, and a DSS tends to encourage communication between the various parts of an organization.

Flexibility

A DSS must be flexible and adaptable in order to incorporate the changes required to reflect modifications in the environment or in the decision-making process.

Data management

The data management module includes a database designed to contain the data required by the decision-making processes to which the DSS is addressed

New Components For DSS Structure

The structure of the DSS shown in Figure 2.8 is extended in Figure 2.9 to include some new components.

1. Data management

2. Model management
3. Interactions
4. Knowledge management

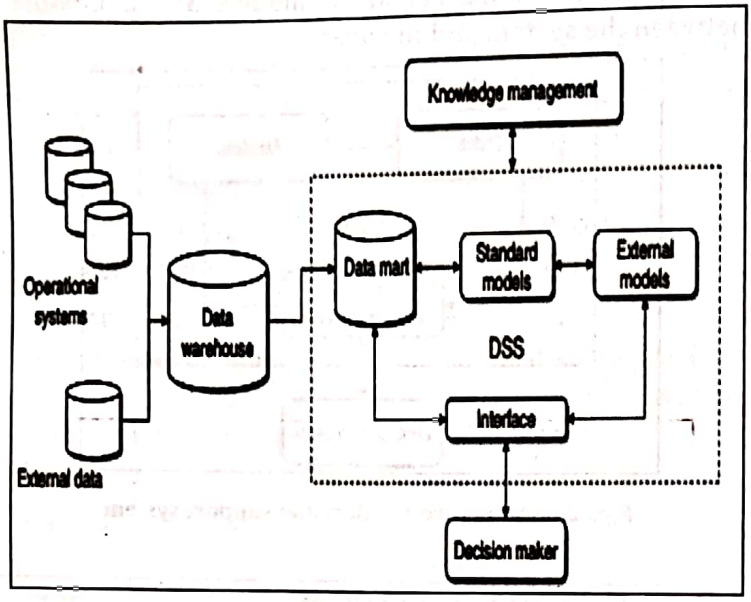

Fig.: 2.9 : Extended structure of a decision support system

1. Data management

The data management module includes a database designed to contain the data required by the decision-making processes to which the DSS is addressed.

2. Model management

The model management module provides end users with a collection of mathematical models derived from operations research, statistics and financial analysis.

3. Interactions

In most applications, knowledge workers use a DSS interactively to carry out their analyses. The module responsible for these interactions is expected to receive input data from users in the easiest and most intuitive way.

4. Knowledge management

The knowledge management module is also interconnected with the company knowledge management integrated system. It allows decision makers to draw on the various forms of collective knowledge, usually unstructured, that represents the corporate culture.

A Summary Of The Major Potential Advantages Deriving From The Adoption Of A DSS:

- An increase in the number of alternatives or options considered;
- An increase in the number of effective decisions devised;
- A greater awareness and a deeper understanding of the domain analyzed and the problems investigated;
- The possibility of executing scenario and what-if analyses by varying the hypotheses and parameters of the mathematical models;
- An improved ability to react promptly to unexpected events and unforeseen situations;
- A value-added exploitation of the available data;

- An improved communication and coordination among the individuals and the organizational departments;
- More effective development of teamwork;
- A greater reliability of the control mechanisms, due to the increased intelligibility of the decision process.
- Unlike other software applications, such as information systems and office automation tools, DSSs are usually not available as standard programs.
- Multidimensional analysis environments have facilitated and standardized the access to passive business intelligence functions.
- Figure 2.10 shows the major steps in the development of a DSS.
- The logical flow of the activities is shown by the solid arrows.
- The dotted arrows in the opposite direction indicate revisions of one or more phases that might become necessary during the development of the system, through a feedback mechanism.

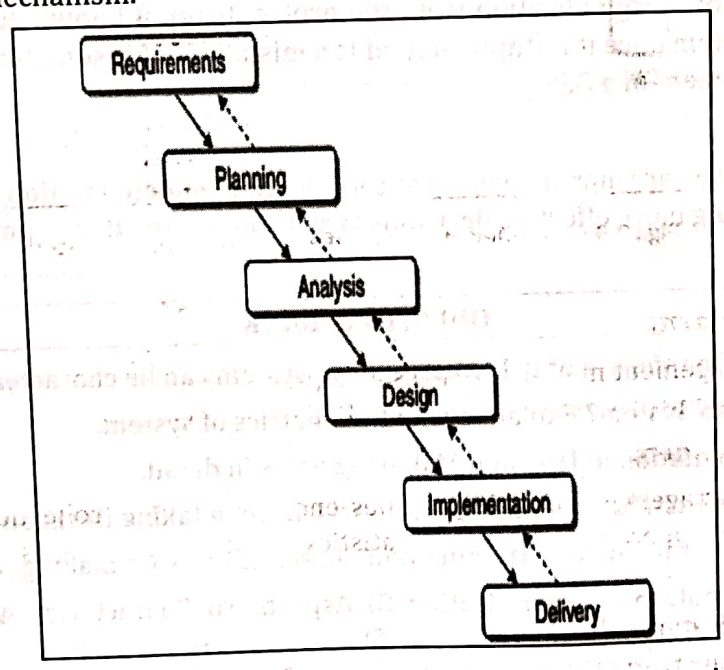

Fig.: 2.10 : Phases in the development of a decision support system

Phases of Development Of A DSS

Planning

The main purpose of the planning phase is to understand the needs and opportunities, sometimes characterized by weak signals, and to translate them into a project and later into a successful DSS.

Analysis

In the analysis phase, it is necessary to define in detail the functions of the DSS to be developed, by further developing and elaborating the preliminary conclusions achieved during the feasibility study.

A response should therefore be given to the following question: *"What should the DSS accomplish, and who will use it, when and how?"*.

Design

During the design phase the main question is : *"How will the DSS work?*

The entire architecture of the system is therefore defined, through the identification of the hardware technology platforms, the network structure, the software tools to develop the applications and the specific database to be used.

Implementation

Once the specifications have been laid down, it is time for implementation, testing and the actual installation, when the DSS is rolled out and put to work. Any problems faced in this last phase can be traced back to project management methods.

Integration

The design and development of a DSS require a significant number of methodologies, tools, models, individuals and organizational processes to work in harmony.

Involvement

The exclusion or marginalization from the project team of knowledge workers who will actually use the system once it is implemented is a mistake that is sometimes made during the design and development of a DSS.

Uncertainty

In general, costs are not a major concern in the implementation of a DSS, and the advantage of devising more effective decisions largely offsets the development costs incurred.

QUESTIONS BANK

1. Define System in refernce of B. I. Explain how system can be characterised?
2. What is Decision System? Explain evaluation metrics of system.
3. Explain representation of Decision Making Process in detail.
4. Explain various Factors influencing a rational choice in taking Decision in system.
5. Explain with diagram logical structure and phases of decision making process system.
6. Write a short note on Summarization Of Aspects To Characterize A Decision Making Process.
7. Explain different types of decision in a system.
8. Write a short note on approaches to the decision making process.
9. What is meant by Information System? Explain Evolution of Information Systems.
10. Explain various New Components For DSS Structure.
11. Explain Major Potential Advantages Deriving From The Adoption of A DSS.

What Is Model & Mathematical Models ?

- A model is a selective abstraction of a real system.
- In other words, a model is designed to analyze and understand from an abstract point of view the operating behavior of a real system, regarding which it only includes those elements deemed relevant for the purpose of the investigation carried out. (Refer Figure 3.1)
- Mathematical models have been developed and used in many application domains, ranging from physics to architecture, from engineering to economics.

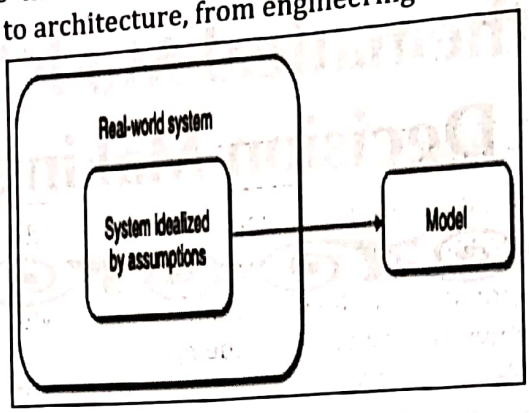

Fig.: 3.1 : A model is a selective abstraction

3.1 STRUCTURE OF MATHEMATICAL MODELS

- Scientific and technological development has turned to mathematical models of various types for the abstract representation of real systems.
- According to their characteristics, models can be divided into iconic, analogical and symbolic.

Iconic

An iconic model is a material representation of a real system, whose behavior is imitated for the purpose of the analysis. A miniaturized model of a new city neighborhood is an example of iconic model.

Analogical

An analogical model is also a material representation, although it imitates the real behavior by analogy rather than by replication.

Symbolic

A symbolic model, such as a mathematical model, is an abstract representation of a real system. It is intended to describe the behavior of the system through a series of symbols variables, numerical parameters and mathematical relationships.

Relevant Distinction W.R.T. Nature of Model

A further relevant distinction concerns the probabilistic nature of models, which can be either stochastic or deterministic.

Stochastic

In a stochastic model some input information represents random events and is therefore characterized by a probability distribution, which in turn can be assigned or unknown.

Deterministic

A model is called deterministic when all input data are supposed to be known a priori and with certainty.

Distinction of Model W.R.T. Temporal Dimension

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3.2 DEVELOPMENT OF A MODEL

- It is possible to break down the development of a mathematical model for decision making into four primary phases, shown in Figure 3.2.
- The figure also includes a feedback mechanism which takes into account the possibility of changes and revisions of the model.

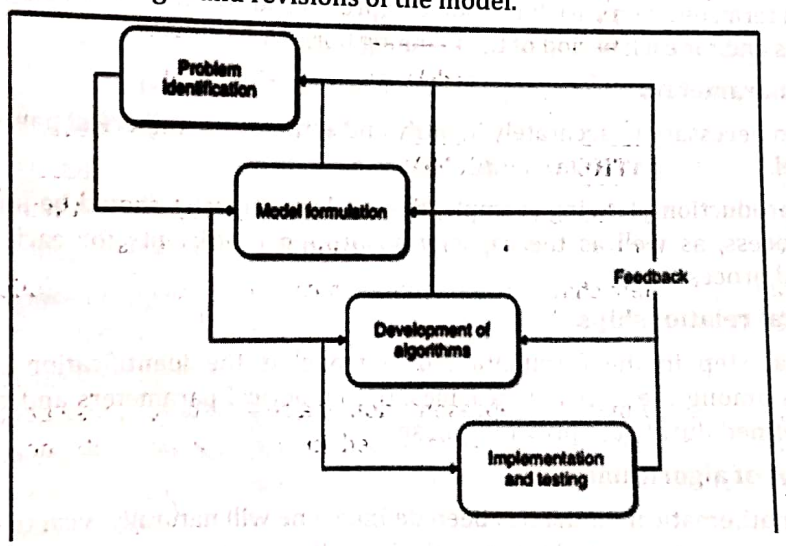

Fig.: 3.2 : Phases in the development of mathematical models for decision making

Primary Phases of Model

Problem identification

First of all, the problem at hand must be correctly identified. The observed critical symptoms must be analyzed and interpreted in order to formulate hypotheses for investigation.

Model formulation

Once the problem to be analyzed has been properly identified, effort should be directed toward defining an appropriate mathematical model to represent the system.

Time horizon

Usually a model includes a temporal dimension.

For example, to formulate a tactical production plan over the medium term it is necessary to specify the production rate for each week in a year, whereas to derive an operational schedule it is required to assign the tasks to each production line for each day of the week.

Model formulation : Primary Phases of Model

Evaluation criteria

Appropriate measurable performance indicators should be defined in order to establi a criterion for the evaluation and comparison of the alternative decisions.

These indicators may assume various forms in each different application, and ma include the following factors:

1. Monetary costs and payoffs;
2. Effectiveness and level of service;
3. Quality of products and services;
4. Flexibility of the operating conditions;
5. Reliability in achieving the objectives

Decision variables

Symbolic variables representing alternative decisions should then be defined.

For example, if a problem consists of the formulation of a tactical production plan ov the medium term, decision variables should express production volumes for each product, fo each process and for each period of the planning horizon.

Numerical parameters

It is also necessary to accurately identify and estimate all numerical parameters require by the model.

In the production planning example, the available capacity should be known in advanc for each process, as well as the capacity absorption coefficients for each combination products and processes.

Mathematical relationships

The final step in the formulation of a model is the identification of mathematic relationships among the decision variables, the numerical parameters and the performanc indicators defined during the previous phases

Development of algorithms:

Once a mathematical model has been defined, one will naturally wish to proceed with it solution to assess decisions and to select the best alternative.

In other words, a solution algorithm should be identified and a software tool tha incorporates the solution method should be developed or acquired.

Implementation and test

When a model is fully developed, then it is finally implemented, tested and utilized in th application domain.

A number of factors should be taken into account at this stage:

- The plausibility and likelihood of the conclusions achieved;
- The consistency of the results at extreme values of the numerical parameters;
- The stability of the results when minor changes in the input parameters are introduced.

3.3 CLASSES OF MODELS

- There are several classes of mathematical models for decision making, which in turn can be solved by a number of alternative solution techniques.
- Each model class is better suited to represent certain types of decision-making

processes.

The main categories of ma

1. Predictive models;
2. Pattern recognition
3. Optimization model
4. Project managemen
5. Risk analysis model
6. Waiting line models

1. Predictive models

- Predictive mod logically placed generally, to th
- Predictions all processes, arisi marketing, pro
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Planning in Optimi

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find:

1. Logistics and
2. Financial plan
3. Work shift pl
4. Marketing ca
5. Price determ

processes.

The main categories of mathematical models for decision making, including:

1. Predictive models;
2. Pattern recognition and learning models;
3. Optimization models;
4. Project management models;
5. Risk analysis models;
6. Waiting line models.

1. Predictive models

- Predictive models play a primary role in business intelligence systems, since they are logically placed upstream with respect to other mathematical models and, more generally, to the whole decision-making process.
- Predictions allow input information to be fed into different decision-making processes, arising in strategy, research and development, administration and control, marketing, production and logistics.
- Prediction models help to forecast the value that a given random variable will assume in the future, based on the values of some variables associated with the entities of a database, as for explanatory models.
- Predictive models can be subdivided into two main categories.
  1. Regression models,
  2. Classification models.
- The purpose of explanatory models is to functionally identify a possible relationship between a dependent variable and a set of independent attributes.

2. Pattern Recognition And Machine Learning Models

- The purpose of pattern recognition and learning theory is to understand the mechanisms that regulate the development of intelligence, understood as the ability to extract knowledge from past experience in order to apply it in the future.

3. Optimization models

- Many decision-making processes faced by companies or complex organizations can be cast according to the following framework: given the problem at hand, the decision maker defines a set of feasible decisions and establishes a criterion for the evaluation and comparison of alternative choices, such as monetary costs or payoffs.
- In general, optimization models arise naturally in decision-making processes where a set of limited resources must be allocated in the most effective way to different entities.

Planning in Optimization Models

Among the main application domains requiring an optimal allocation of the resources we find:

1. Logistics and production planning;
2. Financial planning;
3. Work shift planning;
4. Marketing campaign planning;
5. Price determination.

In light of the structure of the objective function and of the constr optimization models may assume different forms:

1. Linear optimization;
2. Integer optimization;
3. Convex optimization;
4. Network optimization;
5. Multiple-objective optimization.

4. Project Management Models

- A project is a complex set of interrelated activities carried out in pursuit of a spec goal, which may represent an industrial plant, a building, an information syste new product or a new organizational structure, depending on the differ application domains.
- Project management methods are based on the contributions of various disciplin such as business organization, behavioral psychology and operations research.
- Project management methods are based on the contributions of various disciplin such as business organization, behavioral psychology and operations research.
- Mathematical models for decision making play an important role in proje management methods.
- project evaluation and review techniques (PERT), are used to derive the executio times when stochastic assumptions are made regarding the duration of the activitie represented by random variables.

5. Risk Analysis Models

- Some decision problems can be described according to the following conceptual paradigm: the decision maker is required to choose among a number of available alternatives, having uncertain information regarding the effects that these options may have in the future.

6. Waiting Line Models

- The purpose of waiting line theory is to investigate congestion phenomena occurring when the demand for and provision of a service are stochastic in nature.
- If the arrival times of the customers and the duration of the service are not known beforehand in a deterministic way, conflicts may arise between customers in the use of limited shared resources.
- As a consequence, some customers are forced to wait in a line.
- Waiting line models allow the performance of a system to be evaluated once its structure has been defined, and therefore are mostly useful within the system design phase.

Components Of A Waiting Line System

- The main components of a waiting line system are the population, the arrivals process, the service process, the number of stations, and the waiting line rules.
- **The population**, which can be finite or infinite, represents the source from which potential customers are drawn and to which they return once the requested service has been received.
- **The arrivals** process describes how customers arrive at the system entry point.
- **The service** process describes how the providers meet the requests of the customers waiting in line.

- **The number c** station are addi
- **The waiting r** to be admitted
- **A primary ro** assigned to e before all the

1. What Is Model &
2. Explain the diffe
3. Stochastic vs. D
4. Distinction of M
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NITION OF DATA MINING

ta mining activities constitute an iterative process aimed at the analysis of large abases, with the purpose of extracting information and knowledge that may prove rate and potentially useful for knowledge workers engaged in decision making roblem solving.

rm data mining refers therefore to the overall process consisting of data ng and analysis, development of inductive learning models and adoption of l decisions and consequent actions based on the knowledge acquired.

mathematical learning theory is reserved for the variety of mathematical d methods that can be found at the core of each data mining analysis and ed to generate new knowledge.

ining process is based on inductive learning methods, whose main o derive general rules starting from a set of available examples, ast observations recorded in one or more databases.

ediction

tivities can be subdivided into two major investigation streams, main purpose of the analysis: interpretation and prediction.

terpretation is to identify regular patterns in the data and to h rules and criteria that can be easily understood by experts in in.

ust be original and non-trivial in order to actually increase the understanding of the system of interest.

any in the retail industry it might be advantageous to cluster ve taken out loyalty cards according to their purchasing

is to anticipate the value that a random variable will imate the likelihood of future events.

e provider may develop a data mining analysis to robability of churning in favor of some competitor.

el may indicate that the likelihood of future churning tures such as age, duration of the contract and f other phone providers

d in the field of computer science, such as es, and are referred to as machine learning or

athematical methods for learning, such as ed on solid theoretical founda