# Unit 1

## Introduction to Decision support systems and Business Intelligence

| Unit I | Introduction to Decision support systems and Business intelligence | 07 Hours |
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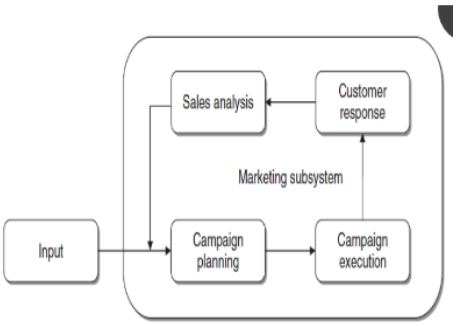
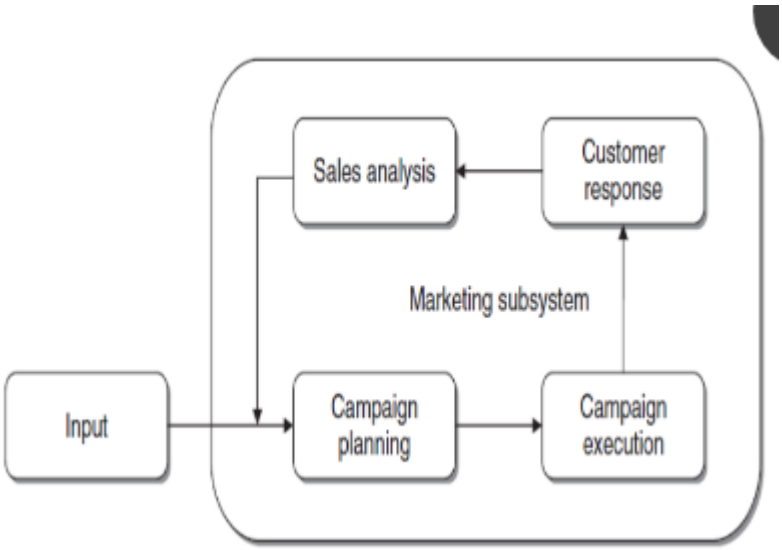
| **Decision support systems:** Definition of system, representation of the decision-making process, evolution of information systems, Decision Support System, Development of a decision support system, the four stages of Simon's decision-making process, and common strategies and approaches of decision makers<br>**Business Intelligence**: BI, its components & architecture, previewing the future of BI, crafting a better experience for all business users, End user assumptions, setting up data for BI, data, information and knowledge, The role of mathematical models, Business intelligence architectures, Ethics and business intelligence | | |

### Definition of system

- A system receives a set of input flows and returns a set of output flows through a transformation process regulated by internal and external conditions.
- The effectiveness and efficiency of a system are assessed using measurable performance indicators that can be classified into different categories.
- A system will often incorporate a feedback mechanism.
- Feedback occurs when a system component generates an output flow that is fed back into the system itself as an input flow, possibly as a result of a further transformation.
- Systems that are able to modify their own output flows based on feedback are called closed-cycle systems.
- e.g.: The figure below describes the development of a sequence of marketing campaigns. The sales results for each campaign are gathered and become available as feedback input so as to design subsequent marketing promotions.




## Representation of the decision-making process

Rationality and problem-solving:

- A decision is a choice from multiple alternatives, usually made with a fair degree of rationality.
- 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. Decision based on Yes/No.
- In other instances, the number of alternatives can be very large or even infinite. For example, the development of the annual logistic plan.

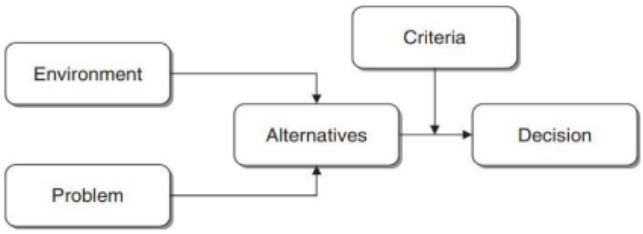
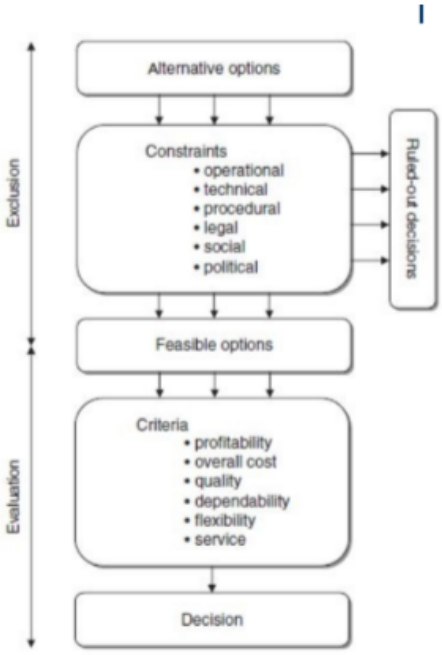



Fig. Logical flow of a problem-solving process

- The process of evaluating the alternatives may be divided into two main stages, shown in Figure: exclusion and evaluation.
- During the exclusion stage, compatibility rules and restrictions are applied to the alternative actions that were originally identified.
- Within this assessment process, some alternatives will be dropped from consideration, while the rest represent feasible options that will be promoted to evaluation.
- In the evaluation phase, feasible alternatives are compared to one another on the basis of the performance criteria, in order to identify the preferred decision as the best opportunity.
- Fig: Logical structure of the decision-making process




The Decision-Making Process:

- Includes five phases - Intelligence, Design, Choice, Implementation, Control

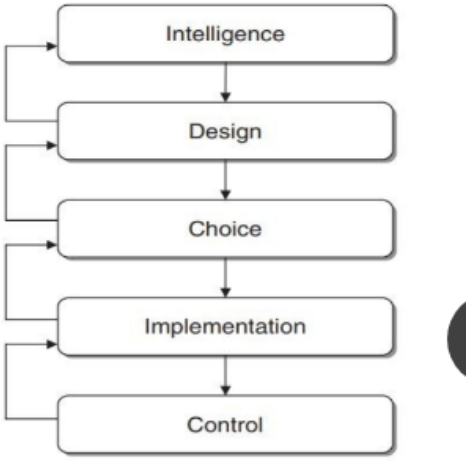


Fig. Phases of the decision-making process

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's 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.
- Where the number of available actions is small, decision-makers can make an explicit enumeration of the alternatives to identify the best solution
- If, on the other hand, the number of alternatives is very large, or even unlimited, their identification occurs in an implicit way, usually through a description of the rules that feasible actions should satisfy.

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
- e.g.: Decision trees can be used to handle decision-making processes influenced by stochastic events.

4. Implementation:

- When the best alternative has been selected by the decision-maker, it is transformed into actions by means of an implementation plan.
- This involves assigning responsibilities and roles to all those involved into the action 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.
- In particular, the differences between the values of the performance indicators identified in the choice phase and the values actually observed at the end of the implementation plan should be measured.

## Evolution of Information System

- First generation (1950s-1960s) : use of mainframe computers and batch processing. Primarily used for record-keeping and transactions such as Payroll & Accounting Systems.
- Second generation (1960s-1970s): use of online transaction processing (OLTP) and the development of specialized systems, such as customer relationship management (CRM) and enterprise resource planning (ERP) systems.
- Third Generation (1980s-1990s): The rise of personal computers and the development of local area networks (LANs) and client-server architecture. This led to the development of more sophisticated systems, such as decision support systems (DSS) and executive information systems (EIS).
- Fourth Generation (1990s-2000s): marked the emergence of the internet and the development of web-based systems. This led to the rise of e-commerce, social media, and cloud computing.
- Fifth Generation (2000s-Present): has been marked by the growth of big data, artificial intelligence, and the Internet of Things (IoT). This has led to the development of new technologies such as machine learning, deep learning, and

predictive analytics which are being used in various areas such as healthcare, finance, retail, and more.

## Decision Support System

- DSS is an interactive computer system helping decision-makers to combine data and models to solve semi-structured and unstructured problems.

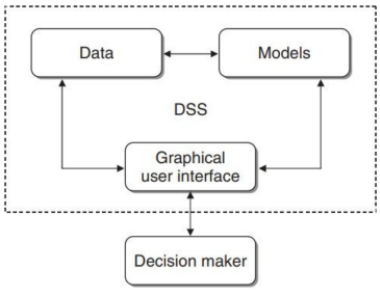


Fig. Structure of a decision support system

- DSS is a computerized system that gathers and analyses data, synthesizing it into reports that provide comprehensive information.
- Different from an ordinary operations application, which only collects data, a decision support system helps you improve your decision-making.

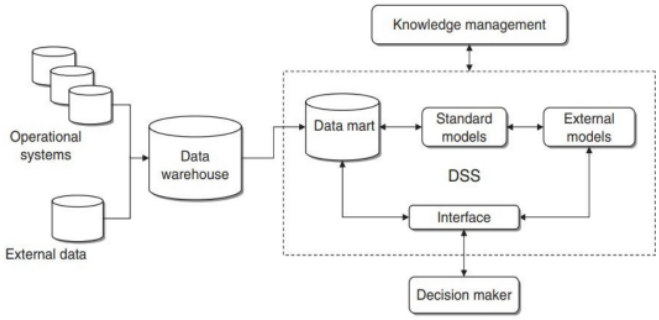


Fig. Extended structure of a decision support system

It mainly contains: Data management, Model management, Interactions, and Knowledge management.

- Generally speaking, any system which provides rational, measurable, and scientific data to help leaders make informed decisions can be considered a decision support system (DSS).
- An example of a decision support system is a manual system, a hybrid system, all types of analytics, and sophisticated decision support tools.

- GPS route planning is one example of how a decision support system might be used.
- When you analyze the options available, a DSS can plan the best route between two points. Traffic is typically monitored in real-time so that congestion can be avoided.
- Decision-support systems are used to make business decisions, often based on data collected by on-line transaction-processing systems.
- Examples of business decisions:

What items to stock?

What insurance premium to change?

To whom to send advertisements?

- Examples of data used for making decisions:

Retail sales transaction details

Customer profiles (income, age, gender, etc.)

- A computer program designed to assist decision-making, judgment, and plans of actions in organizations or businesses.
- Massive amounts of data are gathered and analyzed by a DSS, creating comprehensive information to be used in solving problems and making decisions.
- The use of decision support systems can help businesses make more accurate projections, better manage their inventory, and analyze their data.
- Data collection, organization, and analysis are key features of decision support systems. Inventory management, project sales, and many more features are available through DSS.

## Development of a decision support system

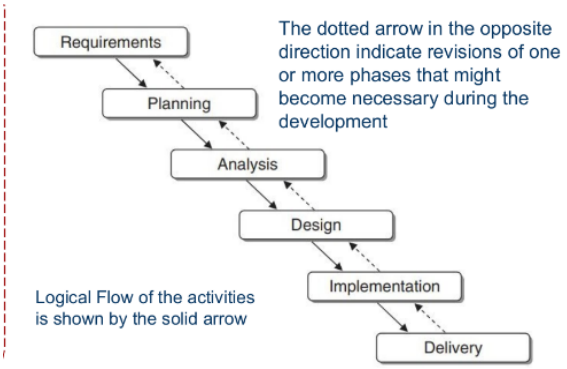


Fig. Phases in the development of a decision support system

- Planning: Why do we wish to develop a DSS?
- Analysis: What should the DSS accomplish, and who will use it; when and how?
- Design: How will the DSS work?
- Implementation:

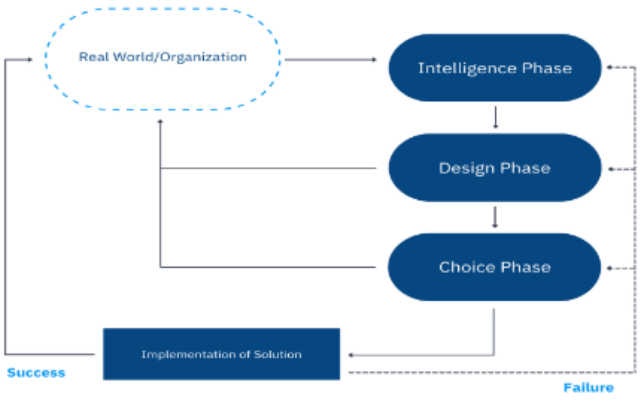
Change management

Rapid prototype development

Agile development technique

Extreme programming technique

## Four stages of Simon's decision-making process




- Simon's decision making model holds four phases:

1. Intelligence phase:

Consist of surveying the environment for situations that demand decisions.

It implies an identification of the problem(s), the collection of information and the establishment of goal and evaluative criteria.

2. Design phase:

Involves delineating and analyzing various courses of action for the problem identified in the intelligence phase.

It implies an enumeration of a combination of feasible alternatives and their evaluation on the basis of the criteria established in the intelligence phase.

3. Choice phase:

Involves selecting the best alternative.

4. Monitor phase (also called review or implementation):

Designed to ensure the proper execution of choice.

## Common strategies and approaches of decision-makers

Types of decision:

- Decisions can be classified in terms of two main dimensions: Nature and Scope
- According to Nature decisions are classified into:

Structured - If it is based on a well-defined and recurring decision-making procedure.

Unstructured - If the 3 phases of intelligence, design, and choice are also unstructured.

Semi-Structured - When some phases are structured and others are not.

- According to Scope decisions are classified into:

Strategic - When they affect the entire organization or at least a substantial part of it for a long period of time.

Tactical - Affects only part of an enterprise and is usually restricted to a single department for a short period e.g.: a year.

Operational - Refer to specific activity carried out within an organization and have a modest impact on the future.

Approaches to the decision-making process

- A preliminary distinction is made between: Rational Approach and Political Organizational Approach
- Rational Approach :

    - The major factors considered will be economic, technical, legal, ethical, procedural, and political.
    - Establishing the criteria of evaluation so as to assess different options and then select the best decision.
    - In this context, a DSS may help both in a passive way, through timely and versatile access to information, and in an active way, through the use of mathematical models for decision-making.
    - Within the rational approach, we can further distinguish between two alternative ways in which the actual decision-making process influences decisions: absolute rationality and bounded rationality.
    - 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.
    - For example, a production manager who has to put together a medium-term logistic plan may be able to convert all performance indicators into monetary units, and therefore subsequently derive the solution with the minimum cost.
    - 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.
    - Therefore, the concept of bounded rationality captures the rational choices that are constrained by the limits of knowledge and cognitive capability.
- Political Organizational Approach :
    - Decisions are not based on clearly defined alternatives and selection criteria.
    - As a consequence, a DSS can only help in a passive way, providing timely and versatile access to information.
    - It might also be useful during discussions and negotiations in those decision-making processes that involve multiple actors, such as managers operating in different departments.

## 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.
- Business Intelligence (BI) refers to skills, processes, technologies, applications, and practices used to support decision-making.
- Systems that provide directed background data and reporting tools to support and improve the decision-making process

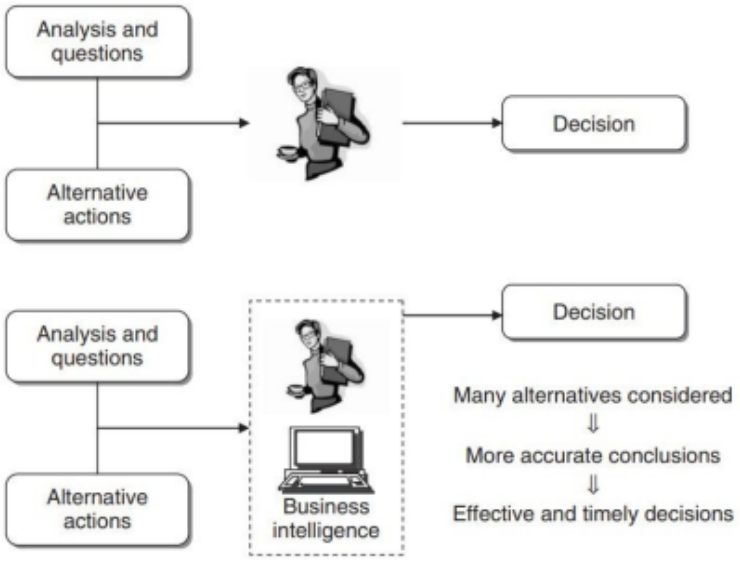



Fig. Benefits of a business intelligence system

- Business intelligence combines business analytics, data mining, data visualization, data tools, infrastructure, and best practices to help organizations make more data-driven decisions.
- A business intelligence system is an infrastructure that can collect, store, and analyze large amounts of data in a centralized location.
- The goal of BI is to give businesses a clear picture of all their meaningful data to allow for better decision-making.
- BI systems can be curated or self-service and are highly customizable to the needs of the business.
- BI Architecture:

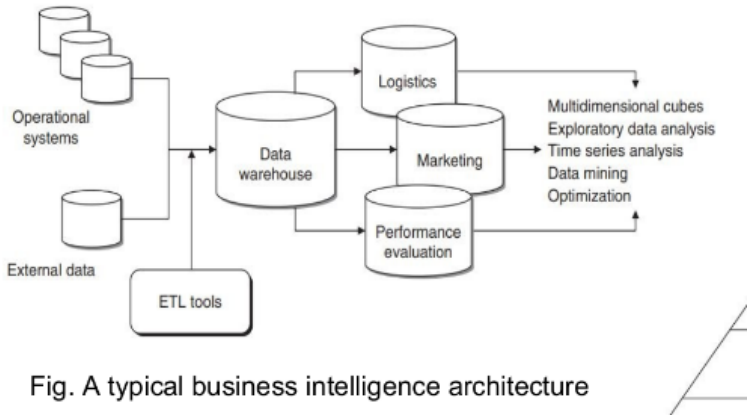
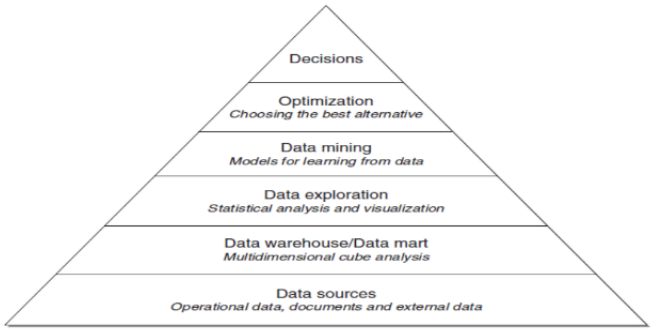



Fig. A typical business intelligence architecture

- It includes three major components:
  1. Data sources
  2. Data warehouses and data marts
  3. Business intelligence methodologies
- Data sources:
  - In the 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.
  - A major effort is required to unify and integrate the different data sources.
- 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.
  - These databases are usually referred to as data warehouses and data marts.
- 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.

- Supports various DSS Applications such as -
    1. multidimensional cube analysis
    2. exploratory data analysis
    3. time series analysis
    4. inductive learning models for data mining
    5. optimization models

- Main components of BI system:




- First two same as above
- 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.
    - For instance, consider the sales manager of a company who notices that revenues in a given geographic area have dropped for a specific group of customers.
    - Hence, she might want to bear out her hypothesis by using extraction and visualization tools, and then apply a statistical test to verify that her conclusions are adequately supported by data.
- 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.
    - Unlike the tools described at the previous level of the pyramid, the models of an active kind do not require decision-makers to formulate any prior hypothesis to be later verified.
    - Their purpose is instead to expand the decision-makers' knowledge.
- 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.
- Decision:
    - 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.
    - Even when business intelligence methodologies are available and successfully adopted, the choice of a decision pertains to the decision-makers, who may also take advantage of informal and unstructured information available to adapt and modify the recommendations and the conclusions achieved through the use of mathematical models.

## Previewing the Future of Business Intelligence

As technology continues to advance at a rapid pace, the future of business intelligence (BI) is looking very exciting. Here are some potential developments that we may see in the coming years:

- **More advanced analytics:** With the rise of big data and machine learning, we can expect to see more advanced analytics tools that can analyze massive amounts of data quickly and accurately. This will enable businesses to make more informed decisions based on real-time insights.
- **Increased automation:** As artificial intelligence (AI) becomes more sophisticated, we may see more automation in the BI space. This could include automated data analysis and reporting, as well as more advanced predictive modeling.

- **Greater integration with other technologies:** As businesses increasingly rely on a variety of technologies to run their operations, we can expect to see greater integration between BI tools and other technologies. For example, BI tools may become more tightly integrated with customer relationship management (CRM) software, allowing businesses to gain deeper insights into customer behavior.
- **More democratization of data:** In the past, BI was primarily the domain of data analysts and other technical professionals. However, we are now seeing a trend towards greater democratization of data, with more business users gaining access to BI tools and insights. This trend is likely to continue in the coming years, as BI tools become more user-friendly and accessible.

Overall, the future of BI looks bright. As businesses continue to generate more and more data, the need for powerful analytics tools will only increase. With advances in technology, we can expect to see more sophisticated BI tools that can help businesses make better decisions and stay ahead of the competition.

## Crafting a better experience for all business users

- Crafting a better experience for all business users involves understanding their needs and providing them with effective tools to analyze data and make informed decisions.
- As the field of business intelligence continues to evolve, it is important to keep in mind the importance of user experience and ease of use.
- BI tools should be designed with the end user in mind, making it easy for them to access the data they need and analyze it in a way that is meaningful to them.
- One way to improve the user experience is through the use of interactive dashboards. Dashboards provide a visual representation of data, making it easy for business users to quickly identify trends and patterns. By incorporating interactive elements, such as filters and drill-down capabilities, users can further explore the data and gain deeper insights.
- Another key aspect of crafting a better experience for business users is providing access to real-time data. With the rise of big data and the Internet of Things (IoT), businesses are generating more data than ever before. By providing real-time access to this data, businesses can respond more quickly to changing market conditions and make more informed decisions.
- Finally, it is important to provide users with training and support to help them get the most out of their BI tools. This includes not only technical support but also

training on how to effectively analyze and interpret data. By providing users with the skills they need to effectively use BI tools, businesses can ensure that they are making the most of their data and driving better results.

## Setting up Data for BI:

- Gather and integrate data from various primary and secondary sources, which are often heterogeneous in origin and type.
- Sources typically consist of data belonging to operational systems, but can also include unstructured documents such as emails and data received from external providers.
- Unify and integrate the different data sources to create a centralized location for data storage.
- Use extraction and transformation tools known as extract, transform, load (ETL) to store data originating from different sources in databases intended to support business intelligence analyses.
- These databases are usually referred to as data warehouses and data marts.
- Data exploration tools consist of query and reporting systems, as well as statistical methods, and are used to perform passive business intelligence analysis.
- Active business intelligence methodologies include mathematical models for pattern recognition, machine learning, and data mining techniques.
- Optimization models allow for the determination of the best solution out of a set of alternative actions.
- To make the best decision, it is necessary to choose the most appropriate business intelligence methodology to use, and to ensure that the chosen methodology is applied in a way that is appropriate to the situation at hand.

## Data, Information, and Knowledge in Business Intelligence

In business intelligence, data, information, and knowledge are distinct concepts that are used in different ways.

- Data: Refers to raw, unprocessed facts and figures. It is the starting point for any analysis in business intelligence. Data can be structured, such as data from a database, or unstructured, such as data from social media.

- Information: Refers to processed data that has been organized and structured in a meaningful way. The information provides context and meaning to data, allowing it to be used for decision-making purposes. For example, a sales report that summarizes sales data by region and product is an example of information.
- Knowledge: Refers to the insights that can be gained from the information. Knowledge is the result of analyzing and interpreting information, and it provides a deeper understanding of the underlying trends and patterns. For example, knowledge might be gained by analyzing the sales report to identify which products are selling well in which regions, and using that knowledge to make decisions about future sales strategies.

## The role of mathematical models

- Mathematical models are a key component of business intelligence, used to extract information and knowledge from data.
- They are used for pattern recognition, machine learning, and data mining, among other techniques.
- Optimization models allow for the determination of the best solution out of a set of alternative actions.
- The choice of the most appropriate business intelligence methodology is necessary to make the best decision, and the chosen methodology must be applied in a way that is appropriate to the situation at hand.

## Business Intelligence Architectures

- Business Intelligence (BI) is a set of mathematical models and analysis methodologies that exploit available data to generate information and knowledge useful for complex decision-making processes.
- A BI system is an infrastructure that can collect, store, and analyze large amounts of data in a centralized location.
- BI combines business analytics, data mining, data visualization, data tools, infrastructure, and best practices to help organizations make more data-driven decisions.
- The BI architecture includes three major components: data sources, data warehouses and data marts, and business intelligence methodologies.
- Data sources consist of data belonging to operational systems, unstructured documents, and data received from external providers.

- Data warehouses and data marts are databases intended to support business intelligence analyses.
- Business intelligence methodologies include passive and active business intelligence analysis tools, mathematical models for pattern recognition, machine learning, and data mining techniques, and optimization models.
- The BI architecture contains tools for performing a passive business intelligence analysis, such as query and reporting systems, as well as statistical methods.
- Data exploration tools consist of tools for performing a passive business intelligence analysis and are used to perform a passive business intelligence analysis.
- Active business intelligence methodologies include mathematical models for pattern recognition, machine learning, and data mining techniques.
- Optimization models allow for the determination of the best solution out of a set of alternative actions.
- A business intelligence system can support various DSS applications such as multidimensional cube analysis, exploratory data analysis, time series analysis, inductive learning models for data mining, and optimization models.

## Ethics and Business Intelligence

In the age of big data, ethics has become an increasingly important consideration in the field of business intelligence. Here are some key ethical considerations to keep in mind:

- **Privacy:** As businesses collect more and more data about their customers, it is important to respect their privacy. This includes obtaining consent before collecting data, using data only for its intended purpose, and securing data against unauthorized access.
- **Transparency:** It is important to be transparent about how data is collected, used, and analyzed. This includes providing clear explanations of data collection practices, as well as making data accessible to those who are impacted by it.
- **Bias:** Data analysis can be subject to biases, whether intentional or unintentional. It is important to be aware of these biases and to take steps to minimize their impact. This includes using representative samples, using diverse data sources, and examining data from multiple perspectives.

- **Accountability:** Businesses must take responsibility for the data they collect and the decisions they make based on that data. This includes being accountable for any negative impacts that may result from data analysis, as well as being transparent about how decisions are made.

In order to ensure ethical business intelligence practices, it is important to establish clear guidelines and procedures for data collection, analysis, and decision-making. This includes establishing a code of ethics for data analysis, as well as providing training and support for employees who work with data.

Ultimately, ethical business intelligence practices are not only important from a moral standpoint but also from a business perspective. By respecting privacy, being transparent, minimizing bias, and being accountable, businesses can build trust with their customers and stakeholders, and ultimately drive better results.