Unit-1

Chapter 2: Decision Support System

(**Reference:** ***Business Intelligence*: *Data Mining and Optimization for Decision Making by Carlo Vercellis***

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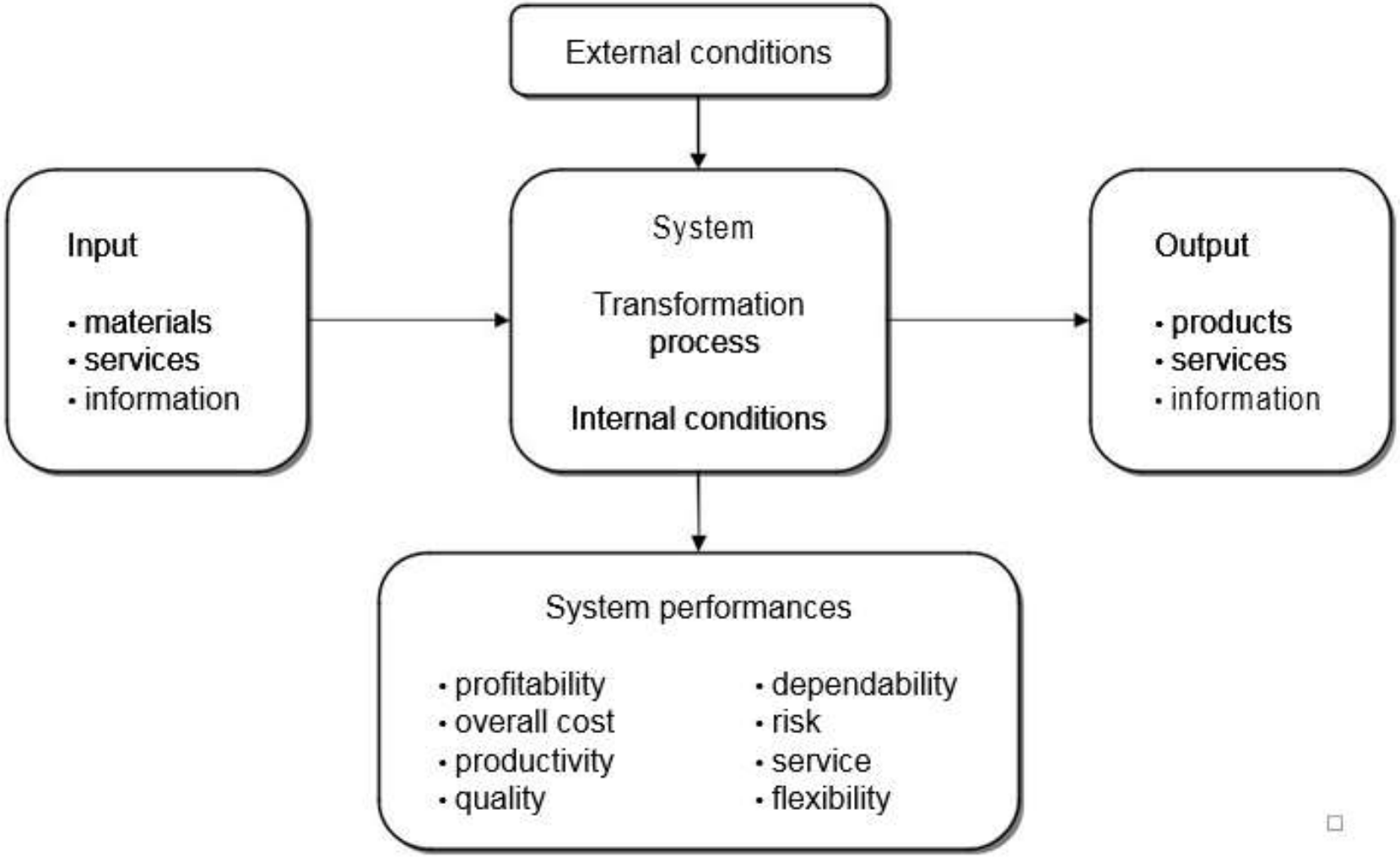
What is Decision Support System?

- 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.
- **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.

- 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.

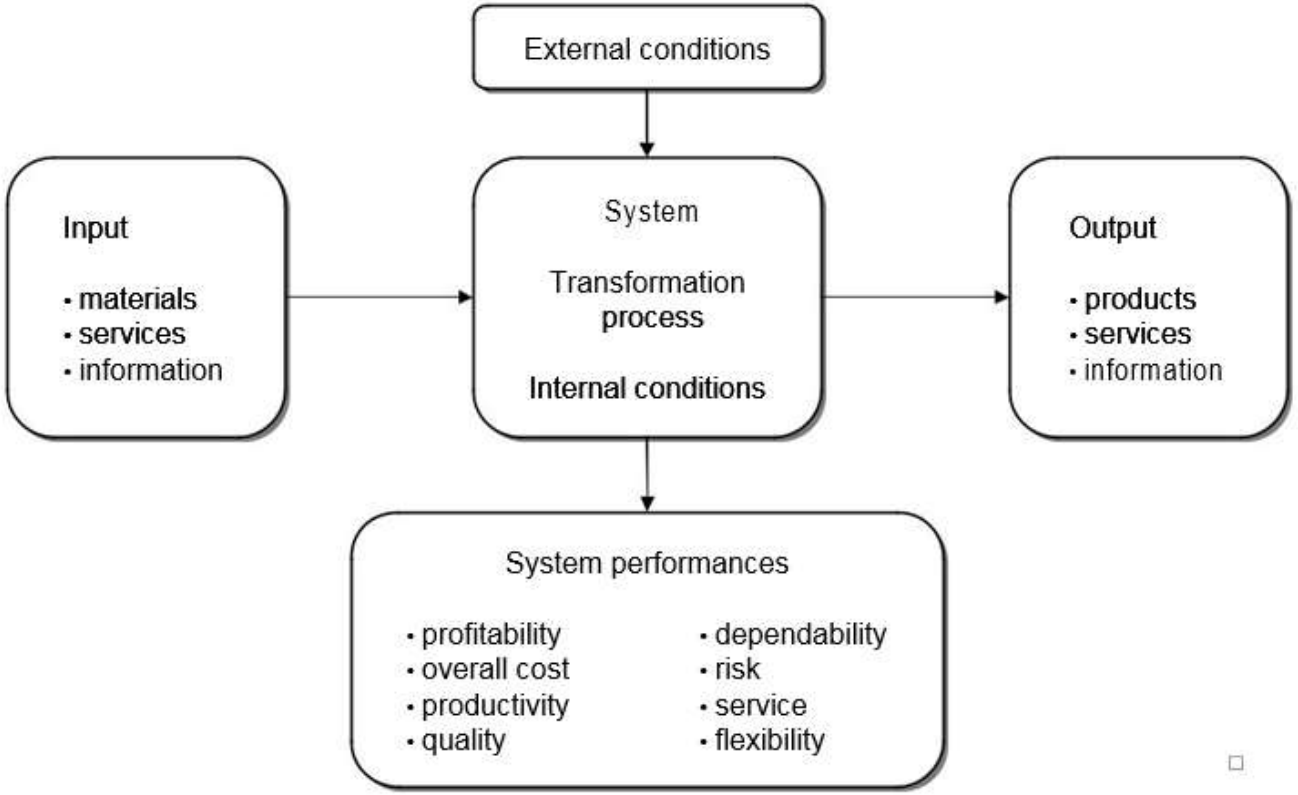
Abstract representation of a system



Abstract representation of a system

Closed System

- Systems that are able to modify their own output flows based on feedback are called ***closed cycle systems.*** For example, the closed cycle system outlined in Figure describes the development of a sequence of marketing campaigns.



Abstract representation of a system

Evaluation Metrics of System:

- It is often necessary to assess the performance of a system. The evaluation metrics are categorized into two main classes: ***effectiveness* and *efficiency.***
- **Effectiveness(doing the right action):** The associated performance indicators are therefore linked to the system output flows, such as production volumes, weekly sales and yield per share.
- **Efficiency(doing the action in best possible way):** Efficiency measurements are therefore associated with the quality of the transformation process. For example, they might express the amount of resources needed to achieve a given sales volume.

Generally speaking, effectiveness metrics indicate whether the *right* action is being carried out or not, while efficiency metrics show whether the action is being carried out in the *best* possible way or not.

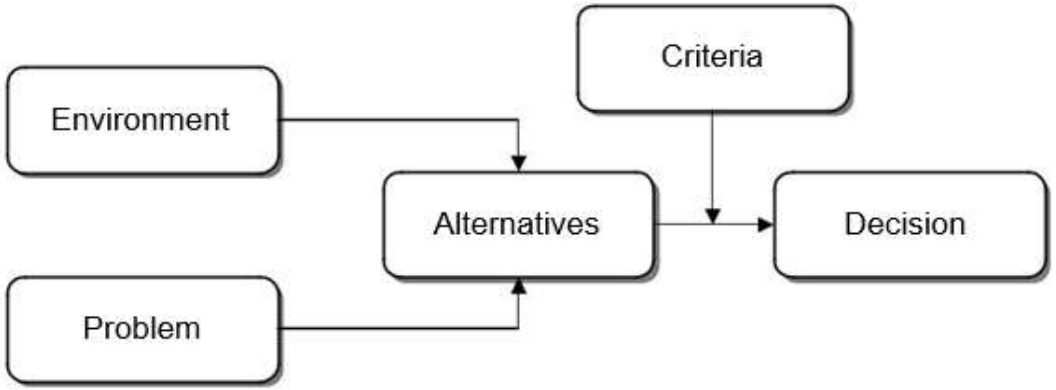
Representation of the decision-making process

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

- **Rationality and problem solving**
- **The decision-making process**
- **Types of decisions**
- **Approaches to the decision-making process**

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. In this section, we will focus on decisions made by knowledge workers in public and private enterprises and organizations.
- 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*).

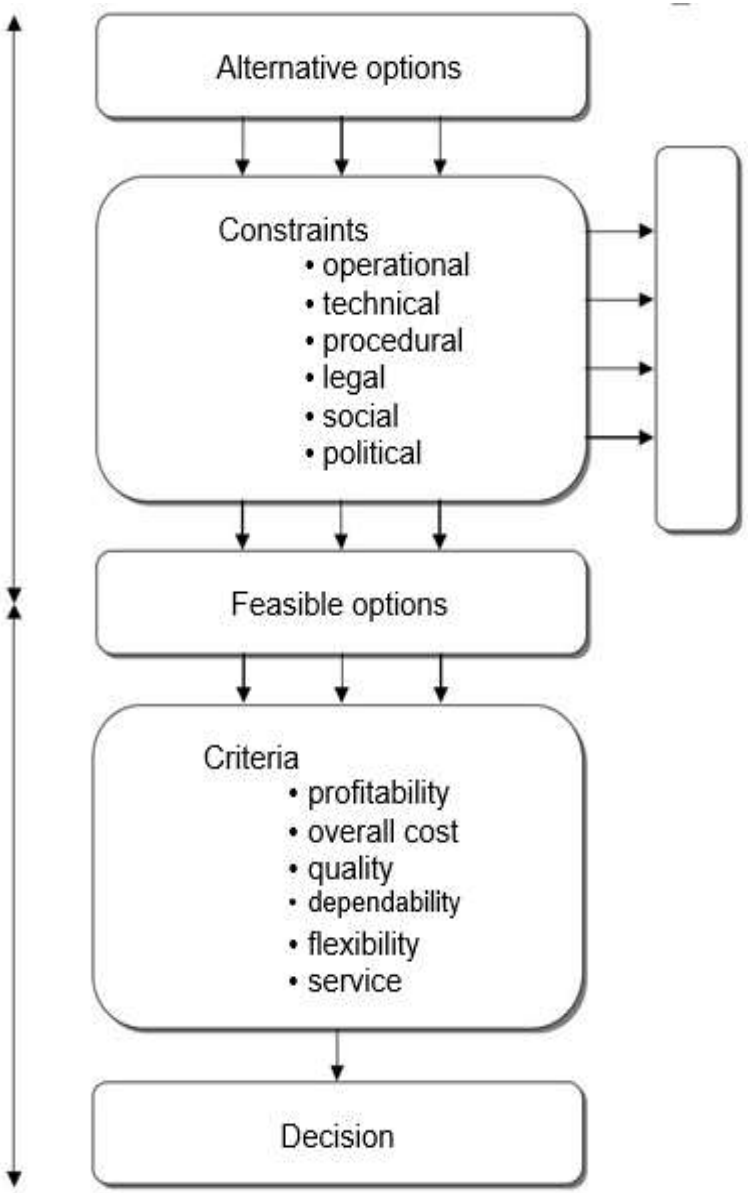


Logical flow of a problem-solving process

Factors influencing a rational choice.

- **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 may be preferred over alternative plans if it achieves a reduction in total costs.
- **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.
- **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.
- **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.
- **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.

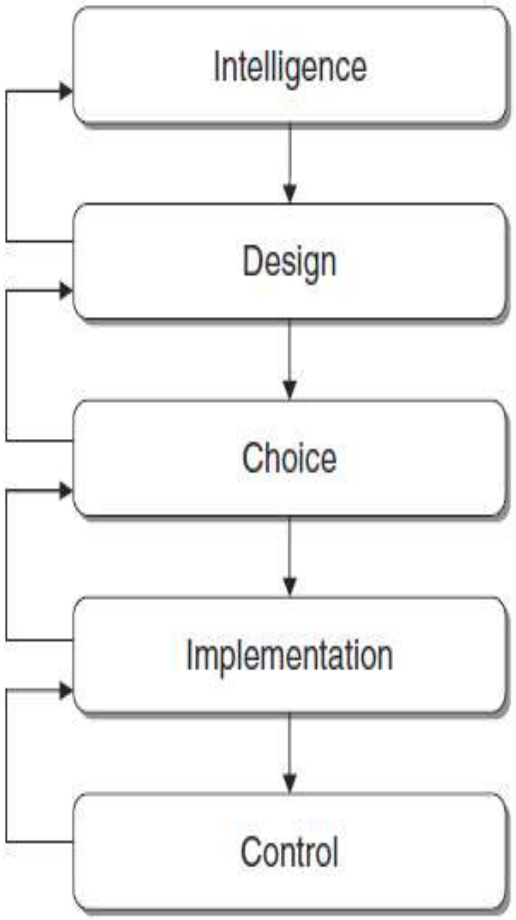
Logical structure of the decision-making process



Logical structure of the decision-making process

The decision-making process: It includes five phases

- **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.
- **Design:** In the *design* phase actions aimed at solving the identified problem should be developed and planned.
- **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.
- **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.
- **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.

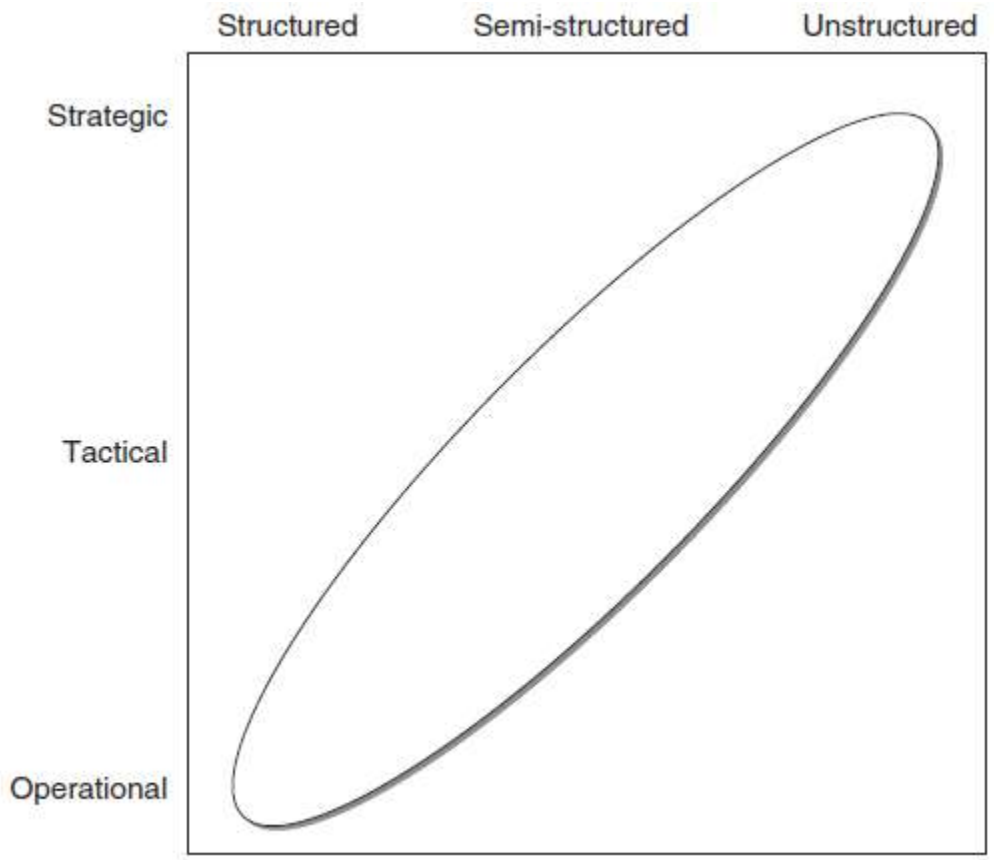


Phases of the decision-making process

Aspects characterizing a decision-making process

- Decisions are often devised by a group of individuals instead of a single decision maker.
- The number of alternative actions may be very high, and sometimes unlimited.
- The effects of a given decision usually appear later, not immediately.
- The decisions made within a public or private enterprise or organization are often interconnected and determine broad effects. Each decision has consequences for many individuals and several parts of the organization.
- 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.
- Feedback plays an important role in providing information and knowledge for future decision-making processes within a given organization.
- In most instances, the decision-making process has multiple goals, with different performance indicators, that might also be in conflict with one another.
- Many decisions are made in a fuzzy context and entail risk factors.
- Experiments carried out in a real-world system, according to a *trial-and-error* scheme, are too costly and risky to be of practical use for decision making.
- 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:



A taxonomy of decisions

According to their nature, decisions can be classified as

- Structured
- Unstructured and
- Semi-structured

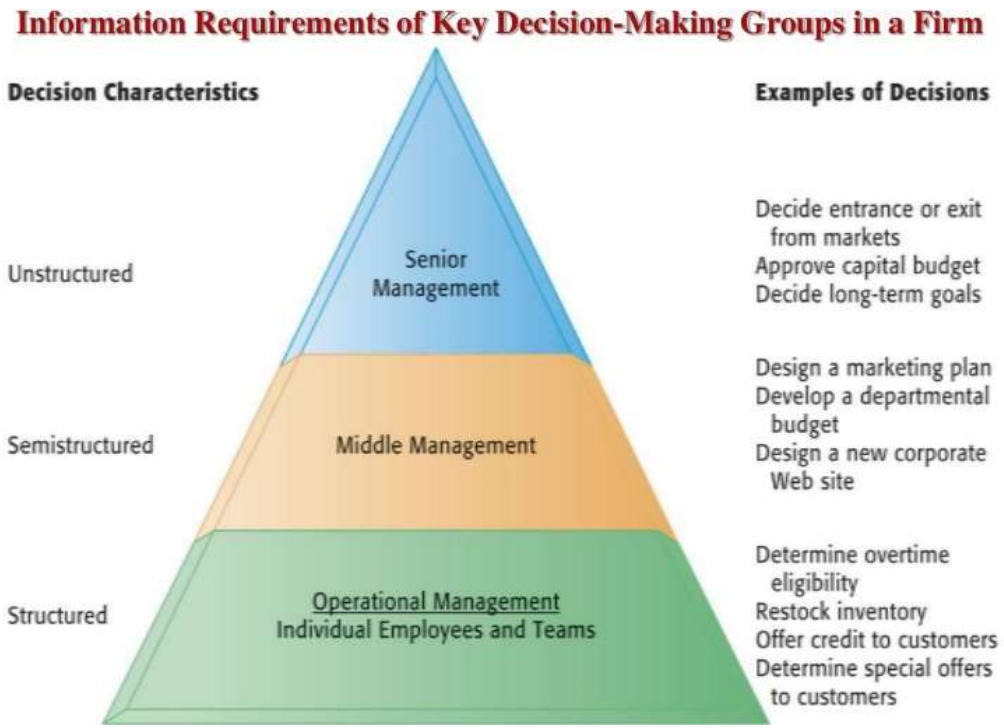
According to their scope, decisions can be classified as

- Operational
- Tactical and
- Strategic

structured decision : A structured decision is one in which the phases of the decision-making process (intelligence, design, and choice) have standardized procedures, clear objectives, and clearly specified input and output. There exists a procedure for arriving at the best solution.

Unstructured decision : An unstructured decision is one where not all of the decision-making phases are structured and human intuition plays an important role.

Semi-structured decision: A semi structured decision has some, but not all, structured phases where standardized procedures may be used in combination with individual judgment.



- **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. They strongly influence the general objectives and policies of an enterprise. Taken at a higher organizational level, usually by the company top management.
- **Tactical decision :** 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. Made by middle managers.
- **Operational decision:** Operational decisions are framed within the elements and conditions determined by strategic and tactical decisions. 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.

Characteristics of the information in terms of the scope of decision.

	Operational	Tactical	Strategic
Accuracy	High	↔	Low
Level of detail	Detailed	↔	Aggregate
Time horizon	Present	↔	Future
Frequency of use	High	↔	Low
Source	Internal	↔	External
Scope of information	Quantitative	↔	Qualitative
Nature of information	Narrow	↔	Wide
Age of information	Present	↔	Past

Characteristics of the information in terms of the scope of decisions

Evolution of Decision making process:

1940-Digital computers made their appearance , and soon began to be applied in the business environment

1970-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.

1980-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.

1990(early)-From the early 1990s, network architectures and distributed information systems based on *client– server* computing models began to be widely adopted. This brought the concept of Datamart and Datawarehouse.

1990(end)- 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

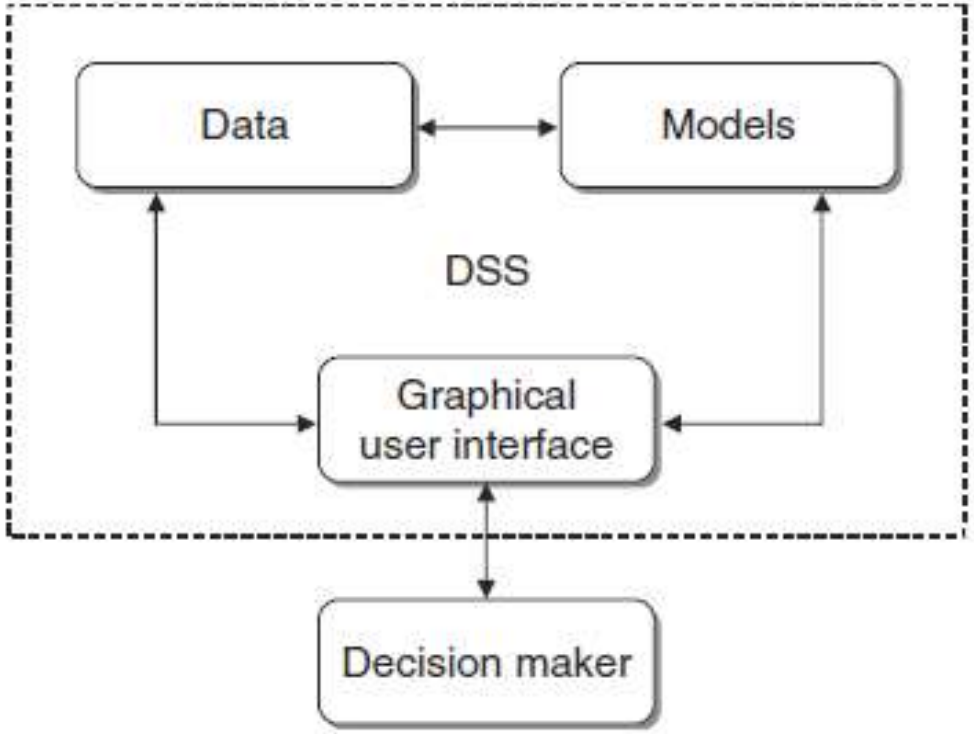
Decision Support Systems:

It contains three elements:

<u>Data</u>: Contains database

<u>Models</u>: Repository(collections) of mathematical Models

<u>Interface</u>: Module for handling the dialogue between the system and the users.

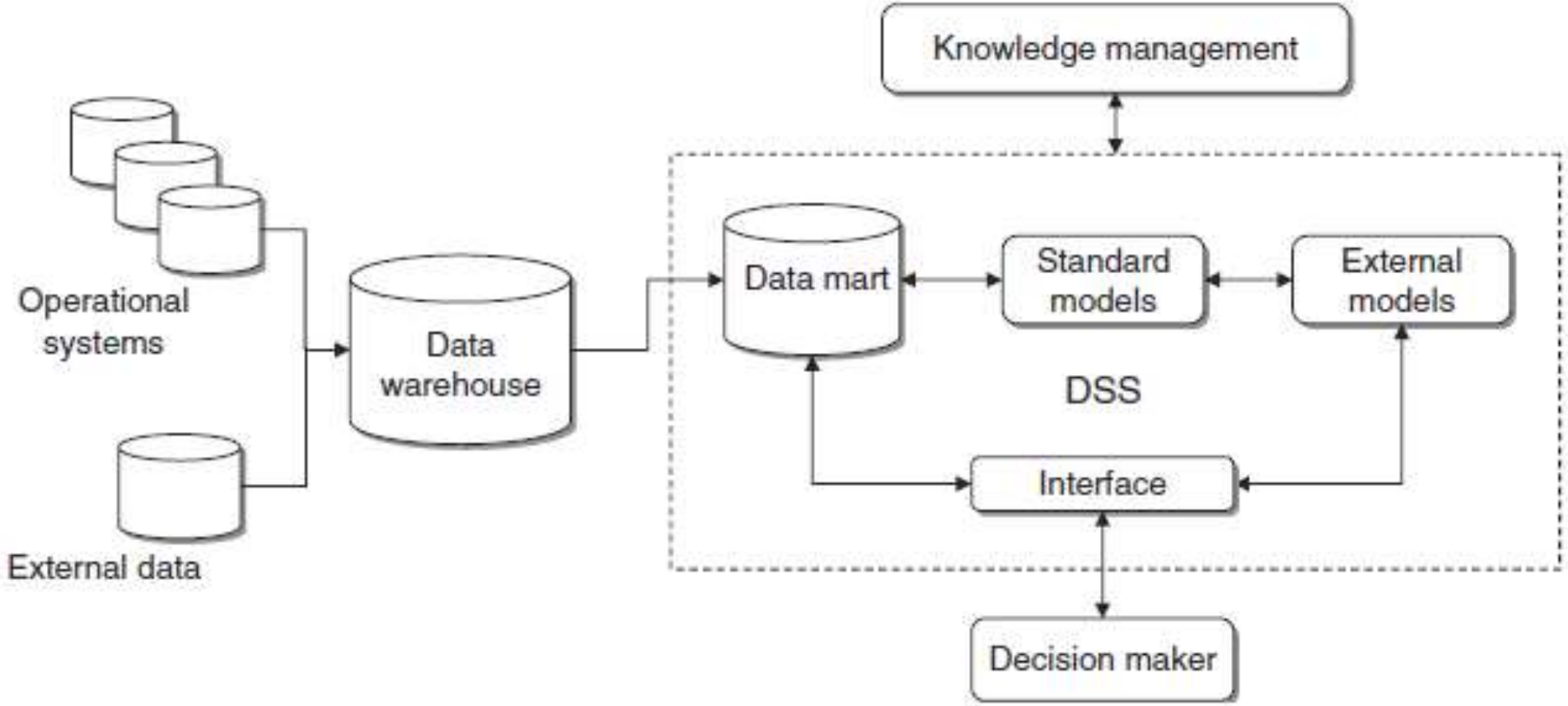


Structure of a decision support system

Features of Decision Support System:

- **Effectiveness:** It should help knowledge workers to reach more effective decisions.
- **Mathematical models:** Mathematical modes are applied to the data contained in data marts and data warehouse.
- **Integration in the decision-making process:** Decision makers allowed to integrate in a DSS to their needs rather than passively accepting what comes out of it.
- **Organizational role:** DSS operate at different hierarchical levels within an enterprise.
- **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**.**

New components for DSS:



Extended structure of a decision support system

continued…

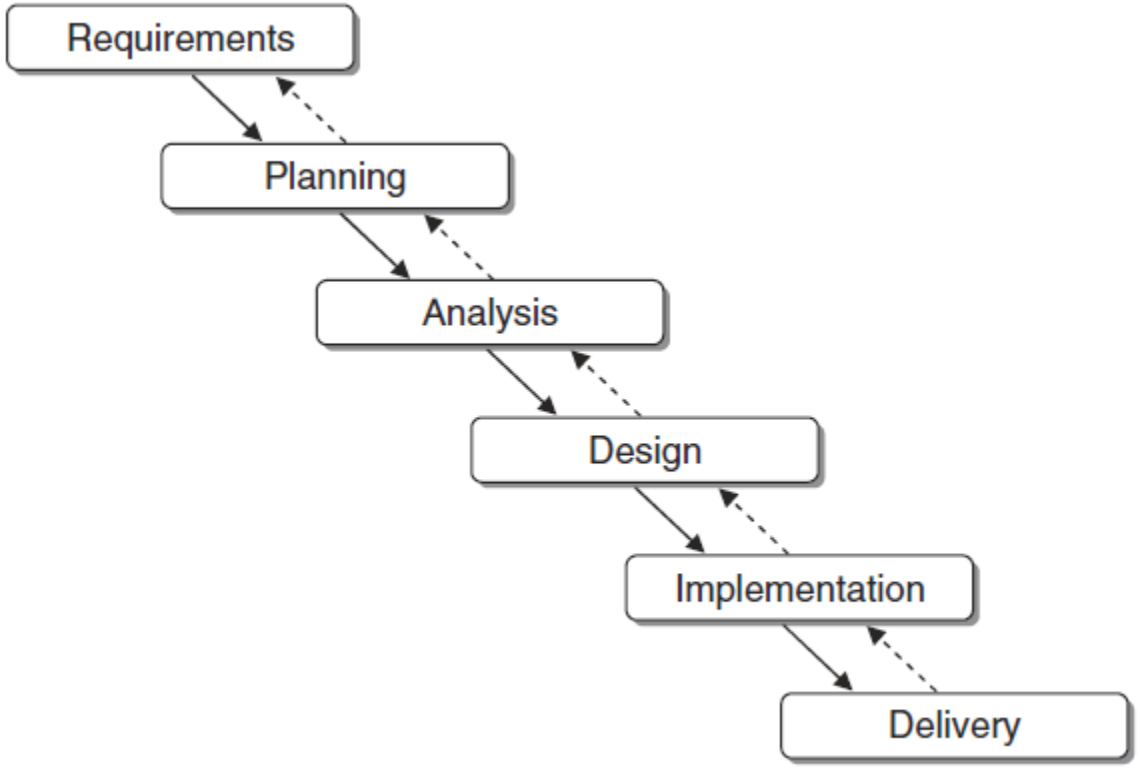
- **Data management:** includes database required to make decisions.
- **Model Management:** Collection of mathematical modes derived from operations research, statistics and financial analysis.
- **Interactions:** Takes inputs from user specifically in graphics forms from browser and gives information and knowledge generated by system.
- **Knowledge management:** It allows decision makers to draw various forms of collective knowledge.

Advantages 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.
- Improved ability to react promptly to unexpected events & 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.

Phases in the development of a DSS

- **Planning**: The main purpose of the planning phase is to understand the needs and opportunities, translate them into project & later into DSS.
- **Analysis**: Define detailed functions of DSS to be developed responses to the questions like *What should the DSS accomplish, and who will use it, when and how?*
- **Design**: How will the DSS work. Hardware + network + Software tools
- **Implementation:** Implementation + installation + testing



Phases in the developement of a decision support system

Factors that may affect the degree of success of DSS:

- **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 feeling of isolation 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 DSS.
- **Uncertainty:** Implementation cost is less but driving more effective decisions may cost more.

Thank you