IS 301 DECISION SUPPORT SYSTEMS

DECISION SUPPORT SYSTEMS AND INTELLIGENT SYSTEMS,
Seventh Edition
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Chapter 1
DECISION-MAKING SYSTEMS, MODELING, AND SUPPORT

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DECISION-MAKING SYSTEMS, MODELING, AND SUPPORT

Learning Objectives

- Understand the conceptual foundations of decision-making
- Understand the systems approach
- Understand the phases of decision-making: intelligence, design, choice, and implementation
- Differentiate between the concepts of making a choice and establishing a principle of choice
- Recognize how decision style, cognition (reasoning), management style, personality, and other factors influence decision-making

DECISION-MAKING

- Decision-making is a process of choosing among alternative courses of action for the purpose of attaining a goal or goals.
- According to Simon (1977), managerial decision-making is synonymous with the whole process of management.
- Consider the important managerial function of planning that involves a series of decisions:
  - What should be done? When? Where? Why? How? By whom?
  - Managers set goals, or plan; hence, planning implies decision-making.

DECISION-MAKING AND PROBLEM-SOLVING

- A problem occurs when a system does not meet its goals, predicted results, or does not work as planned.
- Problem-solving may also deal with identifying new opportunities.
- Differentiating the terms decision-making and problem-solving can be confusing.
- One way to distinguish between the two is to examine the phases of the decision process:

  (1) intelligence, (2) design, (3) choice, (4) implementation.

- Some consider (phases 1-4) as problem-solving, with the choice phase as the real decision-making.
- Others view phases 1-3 as formal decision-making ending with a recommendation. Problem-solving includes the actual implementation of the recommendation (phase 4).

DECISION-MAKING DISCIPLINES

Decision-making is directly influenced by several major disciplines, some behavioral and some scientific in nature.

Behavioral disciplines include :

1. Anthropology
2. Law
3. Philosophy
4. Political science
5. Psychology
6. Social psychology
7. Sociology

DECISION-MAKING DISCIPLINES

Decision-making is directly influenced by several major disciplines, some behavioral and some scientific in nature.

Scientific disciplines include :

1. Computer science
2. Decision analysis
3. Economics
4. Engineering
5. Hard sciences: biology, chemistry, physics, etc.
6. Management science/operations research
7. Mathematics
8. Statistics.

DECISION-MAKING DISCIPLINES

- Each discipline has its own set of assumptions about reality and methods. Also contributes a unique, valid view of how people make decisions. Finally, there is a lot of variation in successful decision in practice.

- A **system** is a collections of objects such as people, resources, concepts, and procedures intended to perform an identifiable function or to serve a goal.

For example, a university is a system of students, faculty, staff, administrators, buildings, equipment, ideas, and rules with the goal of educating students, producing research, and providing service to the community .

- The interconnections and interactions among the subsystems are called **interfaces**.

DECISION-MAKING DISCIPLINES

THE STRUCTURE OF A SYSTEM

- **Systems** (Figure 2.1) are divided into three distinct parts: inputs, processes, and outputs. They are surrounded by an environment and often include a feedback mechanism. In addition, a human decision-maker is considered part of the system.
- **INPUTS** : Inputs are elements that enter the system. Examples of inputs are raw materials entering a chemical plant, students admitted to a university, and data input into a Web page for a database query.

DECISION-MAKING DISCIPLINES

FEEDBACK

- There is a flow of information from the output component to the decision-maker concerning the system's output or Performance.
- The decision-maker compares the outputs to the expected outputs and adjusts the inputs and possibly the processes to move closer to the output targets.

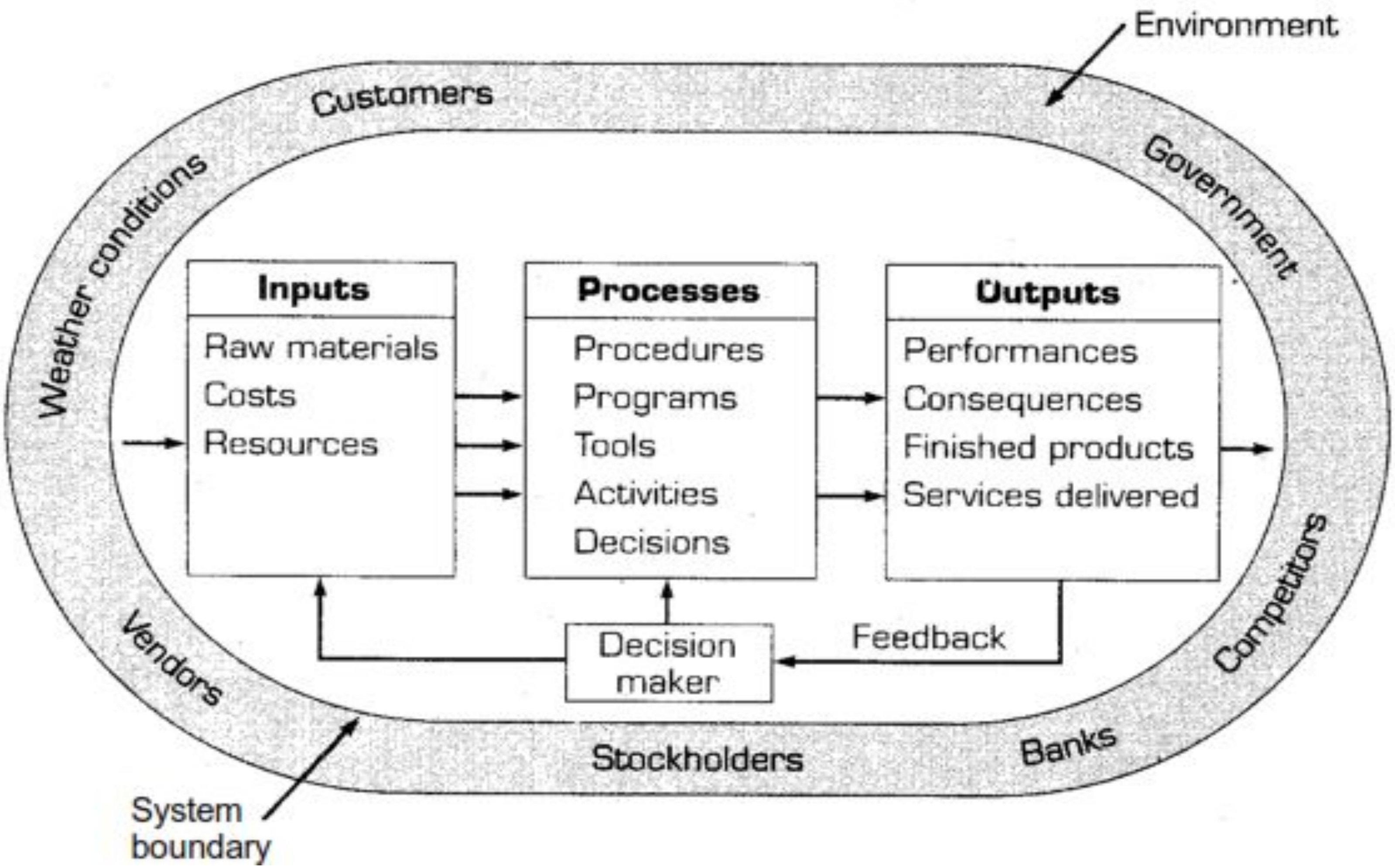
DECISION-MAKING DISCIPLINES

THE ENVIRONMENT

The environment of the system is composed of several elements that lie outside it. One way to identify the elements of the environment is by posing two:

- Does the element matter relative to the system's goals?
- Is it possible for the decision-maker to significantly manipulate this element?
- If and only if the answer to the first question is yes, and the answer to the second is no, is the element in the environment. Environmental elements can be social, political, legal physical, or economic. Often they consist of other systems.

DECISION-MAKING DISCIPLINES



DECISION-MAKING DISCIPLINES

PROCESSES

- Processes are all the elements necessary to convert or transform inputs into outputs. For example, a process in a chemical plant may include heating the materials. In a university, a process may include holding classes, doing library work, and Web searching.

OUTPUTS

- Outputs are the finished products or the consequences of being in the system. For example, fertilizers are one output of a chemical plant, educated people are one output of a university..

DECISION-MAKING DISCIPLINES

THE BOUNDARY

- A system is separated from its environment by a boundary. The system is inside the boundary, whereas the environment lies outside.
- A boundary can be physical (defined by Building ,skin,..), or it can be some nonphysical factor (time, pollution, ..)

The boundary of an information system, especially a decision support system, is by design. Boundaries are related to the concepts of closed and open systems.

DECISION-MAKING DISCIPLINES

CLOSED AND OPEN SYSTEMS

- A closed system is totally independent, whereas an open system is very dependent on its environment.
- An open system accepts inputs (information, energy, materials) from the environment and may deliver outputs to the environment.
- When determining the impact of decisions:
  - Open system, we must determine its relationship with the environment and with other systems.
  - Closed system, we need not do this because the system is considered to be isolated.
- A special type of closed system called a **black box** is one in which inputs and outputs are well defined, but the process itself is not specified

DECISION-MAKING DISCIPLINES

- Decision-support systems attempt to deal with systems that are fairly open.

Factor	Management Science: EOQ (economic order quantity) (Closed System)	Inventory DSS (Open System)
Demand –الطلب	Constant	Variable-influenced by many factors
Unit cost – التكلفة	Constant	May change daily
Lead time- المهلة	Constant	Variable, difficult to predict
Vendors and users - الباعة والمستخدمين	Excluded from analysis	May be included in analysis
Weather and other environmental factors	Ignored	May influence demand and lead time

SYSTEM EFFECTIVENESS AND EFFICIENCY

Systems are evaluated and analyzed in terms of two major performance measures: effectiveness and efficiency.

- Effectiveness فعالية is the degree to which goals are achieved. It is therefore concerned with the outputs of a system (e.g., total sales or earnings per share – ربحية السهم).
- Efficiency كفاءة is a measure of the use of inputs (or resources) to achieve outputs (e.g., how much money is used to generate a certain level of sales).

Peter Drucker proposed

- Effectiveness is doing the right thing.
- Efficiency is doing the thing right

SYSTEM EFFECTIVENESS AND EFFICIENCY

- Companies usually seek to increase and improve the efficiency of their operations and sales processes. After all, when working with limited resources, they would prefer to maximize the use of each of these resources, from budget and technology to time and sales reps.
- However, by pursuing efficiency at all costs (irony intended), some of these companies are missing a valuable chance to take a step back and look at their overall effectiveness from a big picture perspective.

SYSTEM EFFECTIVENESS AND EFFICIENCY

Pursuit of Appropriate Goals / Doing Right Things		Inefficient	Efficient
	Effective	Pursuing right goals, but inefficient (costs are high)	Pursuing right goals and efficient (high-ROI, cost-efficient)
	Ineffective	Pursuing wrong goals and inefficient (not producing enough and are expensive)	Pursuing wrong goals but is efficient (not producing enough but low-cost)

Use of Resources / Doing Things Right

SYSTEM EFFECTIVENESS AND EFFICIENCY

So, emphasis on the effectiveness, or "goodness," of the decision produced, rather than on the computational efficiency of obtaining it-usually a major concern of a transaction processing system.

INFORMATION SYSTEMS AND MODELS

- An information system collects, processes, stores, analyzes, and disseminates information for a specific purpose.
- Information systems are at the heart of most organizations. For example, banks and airlines would be unable to function without their information systems.
- The basic idea is to perform the DSS analysis on a model of reality rather than on the real system. A model is a simplified representation or abstraction of reality.

INFORMATION SYSTEMS AND MODELS

The models are classified, based on their degree of abstraction, as iconic, analog, or mathematical, or simulation

1-ICONIC (SCALE) MODELS

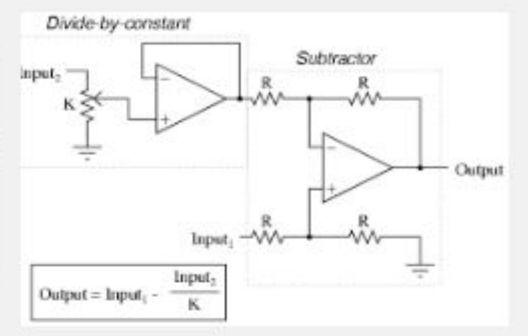
An iconic model is an exact physical representation and may be larger or smaller than what it represents.

- An iconic model is a physical replica of a system, usually on a different scale from the original. (e.g. a house) "
- An iconic model may be three dimensional, such as that of an airplane, car, bridge, or production line. Photographs are two-dimensional iconic-scale models.

INFORMATION SYSTEMS AND MODELS

2-Analog model: use one set of physical movements to represent another set of physical movements. An analogue model may be in the form of a diagram such as a demand curve, histogram, etc. behaves like the real system but does not look like it.

- Organization charts that depict structure, authority, and responsibility relationships
- Maps on which different colors represent objects, such as bodies of water or mountains
- Stock market charts that represent the price movements of stocks
- Blueprints of a machine or a house
- Animations, videos, and movies



INFORMATION SYSTEMS AND MODELS

3-MATHEMATICAL (QUANTITATIVE) MODELS

The complexity of relationships in many organizational systems cannot be represented by icons or analogically because such representations would soon become cumbersome, and using them would be time-consuming. Therefore, more abstract models are described mathematically. Most DSS analyses are performed numerically with mathematical or other quantitative models.

e.g., Let the prey population at time **t** be given by $\mathbf{y_1(t)}$, and the predator population by $\mathbf{y_2(t)}$. Assume that, in the absence of predators, the prey will grow exponentially according to $y_1' = ay_1$ for a certain $\mathbf{a > 0}$. We also assume that the death rate of the prey due to interaction is proportional to $\mathbf{y_1(t)\ y_2(t)}$, with a positive proportionality constant. So:

$$y_1'(t) = a\, y_1(t) - b\, y_1(t)\, y_2(t) \qquad (1)$$

INFORMATION SYSTEMS AND MODELS

Without prey, predators will die exponentially according to $\mathbf{y_2'(t) = -\,ry_2\ dt}$ for a certain $\mathbf{r>0}$. Their birth strongly depends on both population sizes, so we finally find for a certain $\mathbf{c>0}$:

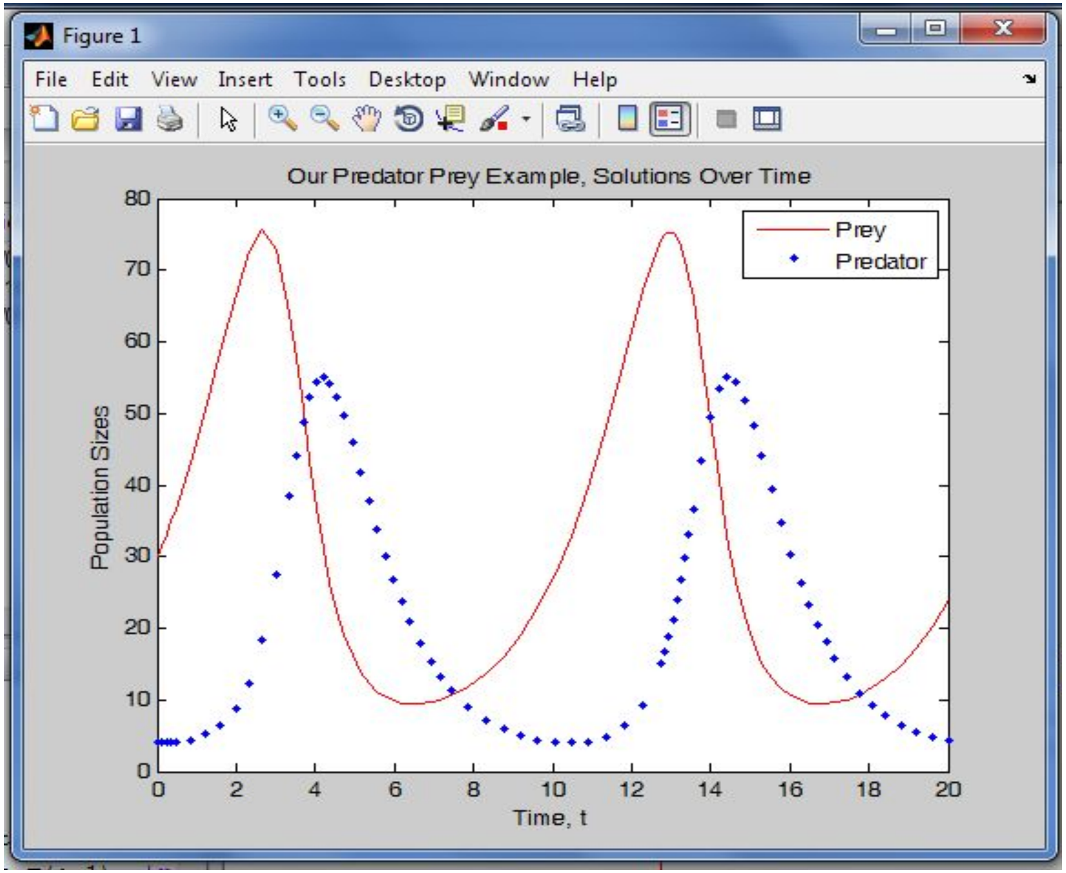
$$\mathbf{y_2'\,(t) = -r\ y_2(t) + c\ y_1(t)\ y_2(t)} \qquad (2)$$

These equations (1) and (2), lead to the following system differential equations:

$$\mathbf{y_1'\,(t) = a\ y_1(t) - b\ y_1(t)\ y_2(t)}$$

$$\mathbf{y_2'\,(t) = -r\ y_2(t) + c\ y_1(t)\ y_2(t)}$$

INFORMATION SYSTEMS AND MODELS



INFORMATION SYSTEMS AND MODELS

4. **Simulation Models**

Simulations models are used when the systems under study are complex and all other models cannot satisfactorily represent the system.

Simulation modeling is the process of creating and analyzing a digital prototype of a physical model to predict its performance in the real world.

Simulation modeling is used to help designers and engineers understand whether, under what conditions, and in which ways a part could fail and what loads it can withstand.

INFORMATION SYSTEMS AND MODELS

THE BENEFITS OF MODELS: uses models for the following reasons:

- Model manipulation (changing decision variables or the environment) is much easier than manipulating the real system. Experimentation is easier and does not interfere with the daily operation of the organization.
- Models enable the compression of time. Years of operations can be simulated in minutes or seconds of computer time.
- The cost of modeling analysis is much less than the cost of a similar experiment conducted on a real system.
- The cost of making mistakes during a trial-and-error experiment is much less when models are used rather than real systems.
- The business environment involves considerable uncertainty. With modeling, a manager can estimate the risks resulting from specific actions.
- Mathematical models enable the analysis of a very large, sometimes infinite, number of possible solutions. Even in simple problems, managers often have a large number of alternatives from which to choose.
- Models enhance and reinforce learning and training.
- Models and solution methods are readily available over the Web.
- There are many Java applets (and other Web programs) that readily solve models.

INFORMATION SYSTEMS AND MODELS

In addition

- Viewing systems from multiple perspectives
- Discovering causes and effects using model traceability
- Improving system understanding through visual analysis
- Discovering errors earlier and reducing system defects
- Exploring alternatives earlier in the system lifecycle
- Improving impact analysis, identifying potential consequences of a change, or estimating modifications to implement a change
- Simulating system solutions without code generation

2.5 PHASES OF THE DECISION-MAKING PROCESS

- Simon says that three major phases: intelligence, design, and choice. He later added a fourth phase, implementation. Monitoring can be considered a fifth phase-a form of feedback. However, we view monitoring as the intelligence phase applied to the implementation phase.
- The decision-making process starts with the intelligence phase. Reality is examined, and the problem is identified and defined. Problem ownership is established as well.
- In the design phase, a model that represents the system is constructed.

2.6 DECISION-MAKING:

THE INTELLIGENCE PHASE

- Intelligence in decision-making involves scanning the environment, either intermittently (discrete) or continuously. It includes several activities aimed at identifying problem situations or opportunities and monitoring the results of the implementation phase of a decision-making process.

PROBLEM IDENTIFICATION

- The intelligence phase begins with the identification of organizational goals and objectives and determination of whether they are being met.
- Problems occur because of dissatisfaction with the status quo الوضع.
- The existence of a problem can be determined by monitoring and analyzing the organization's productivity level.
- Some issues that may arise during data collection and estimation, and thus plague (disaster) decision-makers, are :

PROBLEM IDENTIFICATION

1. Data are not available. As a result, the model is made with, and relies on.
2. Obtaining data may be expensive.
3. Data may not be accurate or precise enough.
4. Data estimation is often subjective.
5. Data may be insecure.
6. Important data that influence the results may be qualitative (soft).
7. There may be too many data (information overload).
8. Outcomes (or results) may occur over an extended period. As a result, revenues, expenses, and profits will be recorded at different points in time.
9. It is assumed that future data will be similar to historical data.

PROGRAMMED VERSUS NONPROGRAMMED PROBLEMS

- Simon (1977) distinguished two extremes issues. At one end of the spectrum are well-structured problems that are repetitive and routine and for which standard models , Simon calls these programmed problems. Such as
  - weekly scheduling of employees,
  - monthly determination of cash flow, and
  - selection of an inventory level
- Other end of the spectrum are unstructured problems, called non-programmed problems, such as undertaking a complex research and development project, evaluating an electronic commerce initiative, determination about what to put on a Web site. .

PROGRAMMED VERSUS NONPROGRAMMED PROBLEMS

- Semi-structured problems fall between the two extremes. Generally, a structured or semi-structured problem tends to gain structure as it is solved..

From Internet .. Here's an example: A Word document is generally considered to be unstructured data. However, you can add metadata tags in the form of keywords and make it easier to be found -- the data is now semi-structured. Nevertheless, the document still lacks the complex organization of the database, so falls short of being fully structured data.

PROBLEM DECOMPOSITION

- Many complex problems can be divided into sub-problems.
- Solving the simpler sub-problems may help in solving the complex problem.
- Poorly structured problems sometimes have highly structured sub-problems.
- Semi-structured problem results when some phases of decision-making are structured while other phases are unstructured, so when some sub-problems of a decision-making problem are structured with others unstructured, the problem itself is semi-structured.

PROBLEM OWNERSHIP

- In the intelligence phase, it is important to establish problem ownership.
- A problem exists in an organization only if someone or some group takes on the responsibility of attacking it and if the organization has the ability to solve it.

2.7 DECISION-MAKING: THE DESIGN PHASE

- The design phase involves finding or developing and analyzing possible courses of action. These include understanding the problem and testing solutions for feasibility. A model of the decision-making problem is constructed, tested, and validated
- Modeling involves conceptualizing the problem and abstracting it to quantitative and/or qualitative form.
- Simplifications are made through assumptions.
- A proper balance between the level of model simplification and the representation of reality must be obtained because of the" benefit/cost trade-off". apperception

SELECTION OF A PRINCIPLE OF CHOICE

- A principle of choice is a criterion that describes the acceptability of a solution approach.
- In a model, it is a result variable.
- Involves how we establish our decision-making objectives
- Are we willing to assume high risk, or do we prefer a low-risk approach? Are we attempting to optimize or satisfice?
- Among the many principles of choice, normative (standard) and descriptive are of prime importance.

NORMATIVE MODELS النماذج المعيارية

- In which the chosen alternative is the best of all possible alternatives.
- One should examine all the alternatives and prove that the one selected is indeed the best. This process is basically optimization
- Optimization can be achieved in one of three ways:
    - Get the highest level of goal meat from resource.. (maximum profit)
    - Find the alternative with the highest ratio of a goal attainment to cost.
    - Find the alternative with lowest cost.

NORMATIVE MODELS

Normative decision theory is based on the following assumptions:

- Maximize the attainment of goals. (More of a good thing is better than less.)
- A decision-making situation, all viable (workable) alternative courses of action and their consequences are known.
- Decision-makers have an order or preference that rank the desirability of all consequences of the analysis (best to worst).

SUBOPTIMIZATION

- Optimization requires a decision-maker to consider the impact of each alternative course of action on the entire organization because a decision made in one area may have significant effects (positive or negative) in other areas.
- Thus, the marketing department should make its plans in conjunction with other departments. Such an approach require a complicated, expensive, time consuming analysis.
- If a suboptimal decision is made in one part of the organization without considering the rest of the organization, then an optimal solution from the point of view of that part may be inferior (lower) for the whole.
- Sub-optimization may also apply when simplifying assumptions are used in modeling a specific problem.

DESCRIPTIVE MODELS

- Models describe things as they are. These models are typically mathematically based. Descriptive models are extremely useful in DSS for investigating the consequences of various alternative courses of action under different configurations of inputs and processes.
- There is no guarantee that an alternative selected with the aid of a descriptive analysis is optimal. In many cases, it is only satisfactory.
- **Simulation** is most common descriptive modeling method. Simulation has been applied to many areas of decision-making.

Classes of descriptive models include

- Complex inventory decision
- Environmental impact analysis
- Financial planning
- Information flow
- Markov analysis (prediction)
- Scenario analysis
- Simulation (alterative types)
- Technological forecasting
- Waiting line (queuing) management

GOOD ENOUGH OR SATISFICING

- Most human decision-making, whether organizational or individual, involves a willingness to settle for a satisfactory solution, "something less than the best."
- The usual reasons for satisficing are time pressure (lose value over time). Essentially, *satisficing is a form of sub-optimization.* There may be a best solution, an optimum, but it is difficult, if not impossible, to attain.

DEVELOPING (GENERATING) ALTERNATIVES

- A significant part of the process of model building is generating alternatives.
- In optimization models (such as linear programming), the alternatives may be generated automatically by the model.
- The Web-based READY portal filters through large amounts of information to select only relevant items for alternative selection.
- The outcome of every proposed alternative must be established. Depending upon whether the decision-making problem is classified as one of certainty, risk, or uncertainty, different modeling approaches may be used.

MEASURING OUTCOMES

- The value of an alternative is evaluated in terms of goal attainment.
- An outcome such as customer satisfaction may be measured by the number of complaints, by the level of loyalty to a product, or by ratings found by surveys.
- When groups make decisions, each group participant may have a different agenda.

SCENARIOS

- A scenario is a statement of assumptions about the operating environment of a particular system at a given time. A scenario describes the decision and uncontrollable variables and parameters for a specific modeling situation.

- It also may provide the procedures and constraints for the modeling.

- Scenario planning and analysis is a DSS tool that can capture a whole range of possibilities. A manager can construct a series of scenarios (what-if cases), perform computerized analyses, and learn more about the system and decision-making problem while analyzing it.

SCENARIOS

Scenarios play an important role in MSS because they:

1. Help identify opportunities and problem areas
2. Provide flexibility in planning
3. Identify the leading edges of changes that management should monitor
4. Help validate major modeling assumptions
5. Allow the decision-maker to explore the behavior of a system through a model
6. Help to check the sensitivity of proposed solutions to changes in the environment as described by the scenario

SCENARIOS

POSSIBLE SCENARIOS

There may be thousands of possible scenarios for every decision situation. However, the following are especially useful in practice:

- The worst possible scenario
- The best possible scenario
- The most likely scenario
- The average scenario

ERRORS IN DECISION-MAKING

The model is the critical component in the decision-making process, but one may make a number of errors in its development and use. Validating the model before it is used is critical.

2.8 DECISION-MAKING: THE CHOICE PHASE

Choice is the critical act of decision-making.

- The choice phase is the one in which the actual decision is made
- The boundary between the design and choice phases is often unclear because certain activities can be performed during both of them and because one can return frequently from choice activities to design activities.
- A solution to a model is a specific set of values for the decision variables in a selected alternative

Note: Solving the model is not the same as solving the problem the model represents. The solution to the model yields a recommended solution to the problem.

2.9 DECISION-MAKING: THE IMPLEMENTATION PHASE

- The implementation of a proposed solution to a problem is, in effect, the initiation of a new order of things, or the introduction of change. User expectations must be managed as part of change management.
- implementation is somewhat complicated because implementation is a long, involved process with vague boundaries.
- Implementation means putting a recommended solution to work, not necessarily the implementation of a computer system.
- Implementation was a little fuzzy