Chapter 2: Foundations and Technologies for Decision Making

Learning Objectives for Chapter 2

1. Understand the conceptual foundations of decision making
2. Understand Simon's four phases of decision making: intelligence, design, choice, and implementation
3. Understand the essential definition of DSS
4. Understand important DSS classifications
5. Learn how DSS support for decision making can be provided in practice
6. Understand DSS components and how they integrate

CHAPTER OVERVIEW

Our major focus in this book is the support of decision making through computer-based information systems. The purpose of this chapter is to describe the conceptual foundations of decision making and how decision support is provided. This chapter includes the following sections:

CHAPTER OUTLINE

2.1 OPENING VIGNETTE: DECISION MODELING AT HP USING SPREADSHEETS

- Questions for the Opening Vignette

A. WHAT WE CAN LEARN FROM THIS VIGNETTE

2.2 DECISION MAKING: INTRODUCTION AND DEFINITIONS

A. CHARACTERISTICS OF DECISION MAKING
B. A WORKING DEFINITION OF DECISION MAKING
C. DECISION-MAKING DISCIPLINES
D. DECISION STYLE AND DECISION MAKERS
   1. Decision Style
   2. Decision Makers

- Section 2.2 Review Questions

2.3 PHASES OF THE DECISION-MAKING PROCESS

- Section 2.3 Review Questions

2.4 DECISION MAKING: THE INTELLIGENCE PHASE

A. PROBLEM (OR OPPORTUNITY) IDENTIFICATION
   - Application Case 2.1: Making Elevators Go Faster!

B. PROBLEM CLASSIFICATION

C. PROBLEM DECOMPOSITION

D. PROBLEM OWNERSHIP
   - Section 2.4 Review Questions

2.5 DECISION MAKING: THE DESIGN PHASE

A. MODELS

B. MATHEMATICAL (QUANTITATIVE) MODELS

C. THE BENEFITS OF MODELS

D. SELECTION OF A PRINCIPLE OF CHOICE
   - Technology Insights 2.1: The Difference Between a Criterion and a Constraint

E. NORMATIVE MODELS

F. SUBOPTIMIZATION

G. DESCRIPTIVE MODELS

H. GOOD ENOUGH OR SATISFICING

I. DEVELOPING (GENERATING) ALTERNATIVES

J. MEASURING OUTCOMES

K. RISK

L. SCENARIOS

M. POSSIBLE SCENARIOS

N. ERRORS IN DECISION MAKING
   - Section 2.5 Review Questions

2.6 DECISION MAKING: THE CHOICE PHASE

- Section 2.6 Review Questions

2.7 DECISION MAKING: THE IMPLEMENTATION PHASE

- Section 2.7 Review Questions

2.8 HOW DECISIONS ARE SUPPORTED

A. SUPPORT FOR THE INTELLIGENCE PHASE

B. SUPPORT FOR THE DESIGN PHASE

C. SUPPORT FOR THE CHOICE PHASE

D. SUPPORT FOR THE IMPLEMENTATION PHASE
   - Section 2.8 Review Questions

2.9 DECISION SUPPORT SYSTEMS: CAPABILITIES

A. A DSS APPLICATION
- Section 2.9 Review Questions

2.10 DSS CLASSIFICATIONS

A. THE AIS SIGDSS CLASSIFICATION FOR DSS
1. Communications-driven and Group DSS
2. Data-driven DSS
3. Document-driven DSS
4. Knowledge-driven DSS, Data Mining, and Management Expert Systems Applications
5. Model-driven DSS
6. Compound DSS

B. OTHER DSS CATEGORIES
1. Institutional and Ad Hoc DSS

C. CUSTOM-MADE SYSTEMS VERSUS READY-MADE SYSTEMS
- Section 2.10 Review Questions

2.11 COMPONENTS OF DECISION SUPPORT SYSTEMS

A. THE DATA MANAGEMENT SUBSYSTEM
- Application Case 2.2: Station Casinos Wins by Building Customer Relationships Using Its Data

B. THE MODEL MANAGEMENT SUBSYSTEM
- Application Case 2.3: SNAP DSS Helps OneNet Make Telecommunications Rate Decisions

C. THE USER INTERFACE SUBSYSTEM

D. THE KNOWLEDGE-BASED MANAGEMENT SUBSYSTEM
- Application Case 2.4: From a Game Winner to a Doctor!
- Technology Insights 2.2: Next Generation of Input Devices

Chapter Highlights
Key Terms
Questions for Discussion
Exercises
Teradata University Network (TUN) and Other Hands-On Exercises
End of Chapter Application Case: Logistics Optimization in a Major Shipping Company (CSAV)
- Questions for the Case

References

TEACHING TIPS/ADDITIONAL INFORMATION

This chapter has two major themes: (a) how decisions are made, and (b) how the decision-making process (and hence the people who make them) can be supported.

Decision making is the subject of Section 2.2 through 2.7. Support is covered in Sections 2.8 through 2.11. (Section 2.1, the introductory vignette, applies equally to

both.) So, the text covers decision making first, and follows it with decision support. Some instructors may prefer to weave in topics of support with topics of decision making, especially when covering the intelligence, design, and choice phases.

It is important to stress the relevance of decision-making methods to DSS/BI in covering this chapter. The key reason is in the word "support" in the term DSS. We are discussing systems that support people who make decisions, not systems that make decisions on their own. People who make business decisions are often high enough in the organization to have choices as to how they make their decisions, so it is important to support decision-making methods and styles that they are willing to use.

One way to view this area is to consider the decision-making system as a whole as consisting of human and automated subsystems. Inputs to the overall system are external and internal (as seen by the organization) data sources and decision requirements. Output is a decision. Internally, the two subsystems communicate in a manner determined by the designers and developers of the automated subsystem. If this is not a suitable interface for the human subsystem, the overall decision-making system will not work well. DSS/BI system designers must see themselves as subsystem designers, where they have limited control over the other major subsystem in the system they are working on, and where they must not suboptimize the automated subsystem at the expense of the overall system. (Suboptimization is covered in this chapter too, in Section 2.5.)

Understanding the phases of decision making is important in developing automated support, as the kind of support needed depends on the decision phase. Teachers should recognize that this subject is taught in several places in the typical business school curriculum, not always from the same point of view. Some instructors draw a strong distinction between decision making and problem solving, whereas this book considers them nearly equivalent. Some instructors consider monitoring to be a fifth phase of the process, whereas this book considers it as the intelligence phase applied to the implementation phase. It is not necessary to be dogmatic about one version of the phases versus another. It can help, however, to determine where else these concepts are taught at your institution and how they are approached there. You may also want to relate Simon's phases with the typical steps of the SDLC process of systems development.

In Section 2.10, this book groups simulation models and other types of mathematical models, such as linear programming, as "mathematical (quantitative) models." Students may have been taught a distinction between the two in other courses such as operations management. You may want to recognize this as being beyond the level of breakdown needed for the purpose of this chapter, but at the same time as valid when a finer classification of models is required.

Section 2.8, "How Decisions Are Supported," gives a wide range of support possibilities for each phase. In teaching this section, which is critical to students' careers because it tells them what to look for in specific situations, it can help to add perspective to the lists in each subsection by indicating which of the listed tools are more important in each phase, which are less so. For example, expert systems are listed as being able to support all four of the decision phases. Although this is correct, you can add perspective by pointing out (in this case) that they are most useful in the choice phase, secondarily in design and implementation, and relatively less useful in the intelligence stage of a decision.

Finally, students may have to be reminded (or told for the first time!) that "criterion" is a singular noun whose plural is "criteria." Saying "The single most important decision criteria is …" is incorrect. Since managers may obtain subconscious clues to a junior staff member's or job applicant's competence from his or her ability to use business terms correctly, it's important for them to learn correct usage when this term comes up in Section 2.5.

ANSWERS TO END OF SECTION REVIEW QUESTIONS

Section 2.1 Review Questions

1. What are some of the key questions to be asked in supporting decision making through DSS?

- Will analytics solve the problem?
- Can an existing tool be leveraged?
- Is a tool needed?

2. What guidelines can be learned from this vignette about developing DSS?

- Before building a model, decision makers should develop a good understanding of the problem that needs to be addressed.
- Coming up with nonmodeling solutions is important because if the problem is due to conflicting priorities, or the misalignment of incentives or unclear lines of authority or plans, then no DSS can help support the decision.
- A model many not be necessary to address the problem.
- Before developing a new tool, decision makers should explore reuse of existing tools.
- The goal of model building is to gain better insight into the problem, not just to generate more numbers.

3. What lessons should be kept in mind for successful model implementation?

- Implementation plans should be developed along with the model. Successful implementation results in solving the real problem.
- Including the end users in the development process enhances the decision makers' analytical knowledge and capabilities. And by working together, their knowledge and skills complement each other in the final solution and the success of the implementation.

Section 2.2 Review Questions

1. What are the various aspects of decision making?

Aspects of decision making that are important to understand if we are to develop effective computer support include the following:

- characteristics of decision making, such as groupthink, experimentation, and information overload
- decision styles of the decision makers
- objectives of the decision makers
- supporting disciplines, styles, and how they relate to the personal characteristics of the decision maker, and the nature of group involvement in the decision (if any)
- rationality of the decision maker. A decision maker should not simply apply IT tools blindly. Rather, the decision maker gets support through a rational approach that simplifies reality and provides a relatively quick and inexpensive means of considering various alternative courses of action to arrive at the best or a good solution to the problem.

2. Identify similarities and differences between individual and group decision making.

- Individual decision makers need access to data and to experts who can provide advice, while groups additionally need collaboration tools.
- There are often conflicting objectives in a group decision-making setting, but not in an individual setting.
- Groups can be of variable size and may include people from different departments or from different organizations. Collaborating individuals may therefore have different cognitive styles, personality types, and decision styles. Some clash, whereas others are mutually enhancing.
- Consensus can be a difficult political problem in group decision making which is not a problem in individual decision making.

For these and similar reasons, group decision making can be more complicated than individual decision making.

3. Define *decision style* and describe why it is important to consider in the decision-making process.

Decision style is the manner in which a decision maker thinks and reacts to problems. It is important to consider it because different decision styles require different types of support.

4. What are the benefits of mathematical models?

They help with many problems faced by decision makers. Mathematical models can be used for what-if analysis, group decision-making, and quickly collecting and analyzing large data sets. Such models enhance the effectiveness of decision making with imperfect and incomplete information. Different models can be applied to different decision styles.

Section 2.3 Review Questions

1. List and briefly describe Simon's four phases of decision making.

Simon's four phases of decision making are intelligence, design, choice, and implementation.

Intelligence consists of gathering information by examining reality, then identifying and defining the problem. In this phase problem ownership should also be established.

Design consists of determining alternatives and evaluating them. If the evaluation will require construction of a model, that is done in this phase as well.

The *choice* phase consists of selecting a tentative solution and testing its validity.

Implementation of the decision consists of putting the selected solution into effect. See Figure 2.1.

2. What are the impacts of the Web on the phases of decision making?

Simon's phases of decision making (intelligence, design, choice, and implementation) apply to many areas, including Web application development. The Web application development framework involves some sort of system lifecycle, which includes all these phases. Of course, the Web provides a wealth of data (mostly unstructured) that can go into the intelligence phase of any decision process. Vendors and service providers operating on the Web also provide some tools that help with design, choice, and implementation tasks.

Section 2.4 Review Questions

1. What is the difference between a problem and its symptoms?

Problems arise out of dissatisfaction with the way things are going. It is the result of a difference or gap between what we desire and what is or is not happening. A symptom is how a problem manifests itself.

A familiar personal example is a high temperature (symptom) and an illness (problem). It is necessary to diagnose and treat the underlying illness. Attempting to relieve the temperature works if the illness is one which the body's defenses can cure, but, can be disastrous in other situations.

A business example: high prices (problem) and high unsold inventory level (symptom). Another is quality variance in a product (symptom) and poorly calibrated or worn-out manufacturing equipment (problem).

2. Why is it important to classify a problem?

Classifying a problem enables decision makers to use tools that have been developed to deal with problems in that category, perhaps even including a standard solution approach.

3. What is meant by *problem decomposition*?

Problem decomposition means dividing a complex problem into subproblems. This helps solve the problem because the smaller subproblems may be simpler to solve; some of the smaller problems may be structured, facilitating their solution, even though the overall problem as a whole is not; solving the *easy* subproblems enables decision makers to focus their attention on the remaining *difficult* parts; and decomposition may facilitate communication among decision makers.

4. Why is establishing problem ownership so important in the decision-making process?

Problem ownership means having the authority, and taking the responsibility, of solving it. Lack of problem ownership means either that someone is not doing his or her job, or that the problem at hand has yet to be identified as belonging to anyone. In either case, it cannot be solved until someone owns it.

Section 2.5 Review Questions

1. Define *optimization* and contrast it with *suboptimization*.

Optimization refers to the "best." (There is no such thing as "more" optimal!) To achieve it, *all* alternatives must be considered, and the optimal one must be the *best*. Suboptimization is the optimization of a subsystem, without considering its

impacts on other parts of the overall system. What is optimal for a part of a system (or organization) may not be for the entire system (or organization). For example, a student spending all 24 final exam study hours on DSS may give him/her the best possible grade in that course, but his/her overall average could be better served by studying six hours for each of four exams. The drop from A+ to B in the DSS course would be more than offset by the improvement from Ds to Bs and Cs in the other three.

2. Compare the normative and descriptive approaches to decision making.

Normative decision making uses models, or methods that have perhaps previously been derived from models that tell a decision maker what he or she should do. These prescriptive models are often developed by utilizing optimization methods. The technology of expert systems, which will be discussed later in the book but which students may have seen elsewhere, derives them from the "rules of thumb" used by recognized experts in the field of the decision.

Descriptive decision making uses models that tell a decision maker "what-if." These are usually simulation models.

3. Define *rational decision making*. What does it really mean to be a rational decision maker?

Rational decision making follows the economic assumptions of rationality. A rational decision maker exhibits certain assumed behaviors: (1) Humans are economic beings, whose objective is to maximize the attainment of goals; (2) for a decision-making situation, all viable alternative courses of action and their consequences, or at least the probability and the values of the consequences are known; and (3) decision makers have an order or preference that enables them to rank the desirability of all consequences of the analysis (best to worst).

Being a rational decision maker means making decisions according to these assumptions.

4. Why do people exhibit bounded rationality when problem solving?

Humans in general have limitations that prevent us from being completely rational. We usually simplify things. Individuals' evaluation scales for the costs and benefits of a decision may be nonlinear and may not follow those of the organization. (For example, a manager may see great personal benefit in not exceeding a budget by even $1, but very little benefit by coming under it by more than a minimal amount. The view from the executive suite would not have such a sharp cut-off. Economic *utility theory* addresses this area.) Also, individual characteristics may result in a restricted rationality.

5. Define *scenario*. How is a scenario used in decision making?

A *scenario* is a statement of assumptions about the operating environment of a particular system in a given time. It describes the system's configurations. By changing scenarios and measuring the goal attainment level, it is possible to compare alternatives under different sets of conditions.

6. Some "errors" in decision making can be attributed to the notion of decision making from the gut. Explain what is meant by this and how such errors can happen.

In general, people have a tendency to measure uncertainty and risk badly. They tend to be overconfident and have an illusion of control in decision making. As a result, decisions in which some part of the future is unknown, which is true of most business decisions, are often made more optimistically than they should be.

In addition, those who decide "from the gut" often do not develop a clear picture of all the details and implications of a situation. This approach can save time if a decision maker's intuition is attuned to a situation from extensive experience, but can lead to errors if it is applied to unfamiliar situations. An executive who has made successful "gut" decisions in the past may not even recognize that his or her experience does not apply to a new, but superficially similar, situation.

Section 2.6 Review Questions

1. Explain the difference between a principle of choice and the actual choice phase of decision making.

A principle of choice is a criterion used to describe the acceptability of a solution approach. In other words, it is a basis for deciding whether one approach or another is superior. A principle of choice is general: that is, it applies to many possible decision-making situations.

The choice phase of decision making uses one or more principles of choice, chosen during this decision phase or prior to it, to select an alternative in a specific situation.

2. Why do some people claim that the choice phase is the point in time when a decision is really made?

Because, in a sense, it is. The decision, choosing one of the available alternatives, is made during this stage. It is, therefore, easy to equate the two.

However, the choice phase as the term is usually used covers more than this single point in time. It also includes the comparisons that lead up to it and the

assessment of robustness and possible adverse consequences that may lead a decision maker to choose an alternative that is less desirable under ideal conditions but also less likely to lead to disaster in other circumstances.

3. How can sensitivity analysis help in the choice phase?

Sensitivity analysis determines how an alternative responds to small changes in the input parameters. An alternative that appears best for the nominal set of parameters might produce far worse results for small changes in them. Another alternative, which might not be as attractive if all parameters have their nominal values, might be more robust—that is, it might not degrade as much if they depart from those values. It might therefore be a better choice in practice, since some statistical variation in these values is only to be expected.

Section 2.7 Review Questions

1. Define *implementation.*

Implementation is defined as the initiation of a new order of things, the introduction of change; putting a recommended solution to work.

2. How can a DSS support the implementation of a decision?

A DSS supports the implementation of a decision through communication, explanation, and justification. In a financial decision, for example, a DSS would include not only the detailed financial goals and cash needs for the near term, but would also provide the calculations, intermediate results, and statistics used to determine the aggregate figures. It also conveys to subordinates that the decision maker has thought through the assumptions behind as decision's goals and is serious about their importance. Finally, it allows people to explain and justify their suggestions and opinions with graphical support.

Section 2.8 Review Questions

1. Describe how DSS/BI technologies and tools can aid in each phase of decision making.

Intelligence phase: The primary requirement of decision support for the intelligence phase is the ability to scan external and internal information sources for opportunities and problems and to interpret what the scanning discovers. Web tools and sources are extremely useful for environmental scanning.

Decision support/business intelligence technologies can also help. (Automatic) data mining and (manual) online analytic processing support this phase by

identifying relationships among activities and other factors. Geographic information systems (GIS) can be utilized either as stand alone or integrated with these systems, so that a decision maker can determine opportunities and problems in a spatial sense.

Another aspect of identifying internal problems and opportunities is monitoring operations. Business activity monitoring, business process management, and product life-cycle management provide such capability. Routine and ad-hoc reports can also help: regular reports can be designed to assist in problem finding by comparing expectations with current and projected performance.

Design phase: This phase involves generating alternative courses of action, agreeing on choice criteria and their weights, and forecasting the consequences of various alternatives. Several of these activities can use standard models such as financial and forecasting models. Either standard or special models can generate alternatives for structured problems. OLAP and data mining software are useful in identifying relationships to use in such models. An expert system can assist with qualitative methods as well as with the expertise required in selecting quantitative analysis and forecasting models.

A knowledge management system, if available, can be consulted to determine whether such a problem has been encountered before, or if there are experts on hand to provide quick understanding and answers. CRM systems, revenue management systems, ERP, and SCM software are useful in providing models of business processes that can test assumptions and scenarios. If a problem requires brainstorming to help identify important issues and options, a group DSS may prove helpful.

Choice phase: In addition to providing models that rapidly identify a best or good-enough alternative, a DSS can support the choice phase through what-if and goal-seeking analyses. Different scenarios can be tested for the selected option to reinforce the final decision. A knowledge management system helps identify similar past experiences; CRM, ERP, and SCM systems can test the impact of each choice. If a group makes the decision, a group support system can provide support to lead to consensus.

Implementation phase: DSS can be used in implementation activities such as decision communication, explanation, and justification. Implementation phase DSS benefits are partly due to the vividness and detail of analyses and reports used for these purposes.

All phases of the decision-making process can be supported by improved communication by collaborative computing through GSS and KMS. Computerized systems can facilitate communication by helping people explain and justify their suggestions and opinions.

Decision implementation can also be supported by expert systems. An ES can be used as an advisory system regarding implementation problems (such as handling resistance to change). Finally, an ES can provide training that may smooth the course of implementation.

Impacts along the value chain are typically identified by BAM, BPM, SCM, and ERP systems. CRM systems report and update internal records based on the impacts of the implementation. These inputs are then used to identify new problems and opportunities—a return to the intelligence phase.

(Note to graders: The text provides additional examples.)

2. Describe how new technologies can provide decision-making support.

With the development of mobile commerce (m-commerce), more and more personal devices (personal digital assistants, cell phones, tablet computers, laptop computers) can access information sources, and users can respond to systems with information updates, collaboration efforts, and decisions. This can help salespeople, for example, to be more effective by accessing their CRM while on the road. Constant access to corporate data, inventory and otherwise, can only help them in their work. Wireless devices are taking on greater importance in the enterprise, generally by accessing specialized Web servers that provide data and communication directly to the m-commerce device.

Section 2.9 Review Questions

1. List the key characteristics and capabilities of DSS.

These are shown in Figure 2.3, and amplified in the text below:

- Support for (mainly) semistructured and unstructured situations, combining human judgment with computerized information.
- Support for all managerial levels, from top executives to line managers.
- Support for individuals and groups.
- Support for interdependent and/or sequential decisions.
- Support all four decision-making phases: intelligence, design, choice, and implementation.
- Support variety of decision-making processes and styles.
- Users can add, delete, combine, change, or rearrange basic elements, or modify them to solve other, similar problems.
- User-friendly interface. (Most new DSS applications use Web-based interfaces.)
- Improves effectiveness of decision making (accuracy, timeliness, quality) rather than its efficiency.

- Decision maker controls all steps of the decision-making process in solving a problem.
- End users can develop and modify simple DSS by themselves; larger DSS require IS specialists.
- Models are generally utilized to enable experimenting with different strategies.
- Access to a variety of data sources, formats, and types, including GIS, multimedia, and object oriented.
- Used by an individual decision maker or distributed throughout one or more organizations.

2. Describe how providing support to a workgroup is different from providing support to group work. Explain why it is important to differentiate these concepts.

A workgroup often works on separate problems within its area of responsibility. For example, a claim processing workgroup in an insurance company may consist of several people who work on their assigned claims by themselves.

In group work, multiple people cooperate to solve the same problem. Insurance claims processing could be group work if handling a claim required the cooperation of policy analysts, medical experts, vehicle dynamics experts, legal experts, and others.

3. What kinds of DSS can end users develop in spreadsheets?

Simple ones—this reflects both the limitations of the spreadsheet as a DSS development tool and the limitations of the typical end user in developing complex information systems.

4. Why is it so important to include a model in a DSS?

The modeling capability of a DSS, which is what differentiates DSS from other MSS, is needed to enable experimenting with different decisions under different configurations and assumptions.

Section 2.10 Review Questions

1. List the DSS classifications of the AIS SIGDSS.

- Communications-driven and group DSS (GSS)
- Data-driven DSS
- Document-driven DSS
- Knowledge-driven DSS, data mining, and management ES applications
- Model-driven DSS
- Compound DSS, hybrids that combine two or more of these categories

2. Define *document-driven DSS*.

A *document-driven DSS* relies on knowledge coding, analysis, search, and retrieval for decision support. This includes all text-based DSS and most KMS. Document-driven DSS have minimal emphasis on mathematical models.

3. List the capabilities of institutional DSS and ad hoc DSS.

An *institutional DSS* is planned and developed to handle a recurring decision. It must have the flexibility to deal with that decision in different manifestations, with different data, over time. Such DSS tend to be used at the managerial control and operational levels.

An *ad hoc DSS* is developed to handle a one-time problem. Such problems typically appear at the strategic and management control levels. Such a DSS need not have the same degree of flexibility as an institutional DSS to deal with variations in the problem. However, problems that were not expected to recur still often do so, or it turns out that the DSS is applicable to other problems as well.

4. Define the term *ready-made DSS*.

A *ready-made DSS* is a DSS software product designed to be used, with minimal modifications, by several organizations that have comparable decision-making needs. Such DSS are often designed for a specific industry (e.g., hospitals) or functional area (e.g., finance).

Section 2.11 Review Questions

(This section has no review questions.)

ANSWERS TO APPLICATION CASE QUESTIONS FOR DISCUSSION

Application Case 2.1: Making Elevators Go Faster!

(This application case has no discussion questions.)

Application Case 2.2: Stations Casinos Wins by Building Customer Relationships Using Its Data

1. Why is this decision support system classified as a data-focused DSS?

A major part of this system involves integration of data from over 500 data sources, incorporated in a Teradata data warehouse. This falls under the category

of data-driven DSS. Cognos is a tool that provides OLAP cube functionality, which is another characteristic of data driven DSS systems.

2. What were some of the benefits from implementing this solution?

Enhanced customer segmentation allowing for targeted marketing, reduced promotion costs, improved member retention, and increased profit.

Application Case 2.3: SNAP DSS Helps OneNet Make Telecommunications Rate Decisions

(This application case has no discussion questions.)

Application Case 2.4: From a Game Winner to a Doctor!

1. What is a cognitive system? How can it assist in real-time decision making?

A cognitive system is a knowledge-based DSS model that applies domain knowledge in a particular field (like medicine) and applies human-like reasoning processes, including natural language processing, hypothesis generation, and evidence-based machine learning to assist in problem solving. Watson is a cognitive system that utilizes many AI algorithms and techniques to support medical decision making. Such systems can provide quick answers to complex problems, whereas individual physicians don't have the time to study all the relevant literature and obtain that level of knowledge.

2. What is evidence-based decision making?

Evidenced-based decision making is a term often associated with current practices in medicine, and is contrasted with just making decisions based on tradition or conventional wisdom. It involves the use of scientific results and clinical trials, statistical analyses, cost-benefit models, and other DSS-relevant approaches.

3. What is the role played by Watson in the discussion?

Watson brings the intelligence that made it such a daunting *Jeopardy!* contestant into the medical world by serving as a decision support system (Dr. Watson). Watson facilitates evidence-based support for its suggestions and provides a platform for physicians to look at a case from multiple perspectives. Watson also aids insurance providers in detecting fraudulent claims and protecting physicians from malpractice suits.

4. Does Watson eliminate the need for human decision making?

No, Watson is used by physicians to support and improve their decision-making capabilities. In this sense, Watson is not operating as an automated decision system (ADS), but more of an expert system (ES).

ANSWERS TO END OF CHAPTER QUESTIONS FOR DISCUSSION

1. Why is intuition still an important aspect of decision making?

Intuition is a critical factor that decision makers use in solving unstructured and semi-structured problems. The best decision makers recognize the tradeoff between the marginal cost of obtaining further information and analysis versus the benefit of making a better decision. (General Patton's adage, "A good decision today is better than a perfect decision tomorrow," reflects the application of this principle to his situation.) When decisions must be made quickly, the intuition of a seasoned, excellent decision maker is called for ideally. When an inexperienced or ill-trained decision maker attempts to use intuition, however, disaster can strike.

(See the related answer to Review Question 6 of Section 2.6 above.)

2. Define *efficiency* and *effectiveness*, and compare and contrast the two.

Efficiency refers to the proper utilization of resources, doing things right.

Effectiveness refers to the attainment of goals, doing the right things.

Driving from New York City to Boston by way of Chicago in a hybrid compact that gets 50 miles per gallon (21 km/liter) may be efficient, but is not effective (in terms of reaching the goal, Boston, quickly).

Driving directly, but alone in a large vehicle that gets 12 mpg (5 km/l), may be effective but is not efficient as it uses four times the resources—in some sense, wasting 75 percent of them.

Ideally, one should be both effective and efficient, but if that is not possible a decision maker should focus on effectiveness.

3. Why is it important to focus on the effectiveness of a decision, not necessarily the efficiency of making a decision?

The effectiveness of a decision affects an organization for as long as the decision matters, and as broadly as the decision scope. The efficiency of making the decision affects only the decision-making process itself. Since the resources involved in making a decision are far less than those affected by its

implementation, it is more important to make sure the decision is correct than to save resources used in making it.

4. What are some of the measures of effectiveness in a toy manufacturing plant, a restaurant, an educational institution, and the U.S. Congress?

Toy manufacturing plant: Cost per unit produced, percent of orders delivered on time, quality of finished product (perhaps measured by number of defects per output or the incidence of warranty claims).

Restaurant: Revenue per table per shift, percent of repeat customers, rate of return on investment, rating by professional reviewers, rating by local health inspection authorities.

Educational institution: Students' performance on national tests, number of students getting jobs in their discipline after graduation, amount of funded research per faculty member, percentage of students successfully finishing and receiving degrees, success of athletic teams.

U.S. Congress: Number of bills passed per year, public image.

Since these are not the only measures for any of the examples, other correct answers are possible.

5. Even though implementation of a decision involves change, and change management is very difficult, explain how change management has *not* changed very much in thousands of years. Use specific examples throughout history.

Moses, while attempting to lead the children of Israel away from idol worship, found them rebellious and often desiring to return to slavery in Egypt rather than face the unknown of the desert. When he left them for a few days, they reverted to idolatry with the Golden Calf.

Many of those living in England's North American colonies in the 1770s preferred the security and known economic benefits of that form of government to the possible benefits, but unknown risks, of independence.

Railroads of the 1950s and 1960s could not adapt to the changes required to see themselves as in the transportation business and therefore lost most of their passengers to airlines and buses.

U.S. automobile companies in the 1970s did not change their products from the large cars, built and bought with the expectation of being traded in frequently, that they were used to. As a result, they lost market share to foreign firms, whose cars offered higher quality and better fuel economy.

Of course, many other examples are possible.

6. Your company is considering opening a branch in China. List typical activities in each phase of the decision (intelligence, design, choice, and implementation) of whether to open a branch.

Intelligence: Should we invest in China? What are the possible advantages, disadvantages, risks? What resources would have to be diverted from other activities? When could we start?

Design: Select criteria for assessing the alternatives (e.g., the ROI, market share); create alternatives: invest now, invest later, do not invest; levels and timing of investment; information flow for decision making; prepare a model; how will the choice be made, by whom, and when?

Choice: Get information; final evaluation; sensitivity analysis; solve model.

Implementation: Prepare an implementation plan; deal with resistance to change and necessary approvals and authorizations; conduct training; transfer resources.

These are not the only possible activities for any of the phases; many other correct answers are possible.

7. You are about to buy a car. Using Simon's four-phase model, describe your activities at each step.

Intelligence: You recognize that your needs could be better served by a different car, due to a change in your present car (decreasing reliability, growing repair bills) or your situation (changed transportation needs, more money).

Design: Determine parameters that describe the appropriate car to buy. Also determine the criteria (objective function) that indicates the value of certain features in a car. From the multiple criteria, a principle of choice should be developed. The alternatives must be identified as well. This is a multiple-criteria problem. In assessing alternatives, it may be necessary to visit dealers to drive candidate cars and determine actual selling prices.

Choice: Choose the car.

Implementation: Buy the car.

8. Explain, through an example, the support given to decision makers by computers in each phase of the decision process.

Intelligence: A computer can scan a large amount of information to identify problems such as a decline in sales.

Design: To boost sales, several advertising proposals may be evaluated. A computerized model that shows the cost of an advertising program and its expected effect on sales can help a decision maker assess their potential.

Choice: Once alternatives are identified and their potential effect forecasted, a choice can be made. The computer can rank choices by cost/benefit ratio, net benefit, or any other desired criterion.

Implementation: A detailed "what-if" analysis can convince management that the proposed alternative is indeed the best. Computer-generated graphics can ease the implementation process.

9. Some experts believe that the major contribution of DSS is to the implementation of a decision. Why is this so?

Proposed solutions are no good unless they are implemented. Implementation in many cases is the most difficult phase of decision making. However, a specific DSS may be designed to help with any decision phase or phases, in which case the contribution of that DSS is to those phases.

10. Review the major characteristics and capabilities of DSS. How do each of them relate to the major components of DSS?

The characteristics and capabilities of DSS are listed in Figure 2.3 as follows. Their relationship to the major components of DSS is noted after each one.

- Semistructured and unstructured problems: The nature of all DSS components reflects this.
- Support managers at all levels: A given DSS may be oriented more toward one level than others. This will be reflected in its user interface.
- Support individuals and groups: DSS designed to support groups must include communication features in their user interface component.
- Interdependent or sequential decisions: This is controlled by the decision maker.
- Support all four decision phases: intelligence, design, choice, and implementation. The DSS must incorporate models, and optionally knowledge-based capabilities, appropriate to each phase. The data and user interface will in most cases be common to all phases.
- Support variety of decision processes and styles: This relates primarily to the user interface. It also relates to the models (and knowledge-based system, if present), because decision makers with different styles will want different levels of analytical support.

- Adaptable and flexible: Primarily a function of the user interface, secondarily reflected in the variety of models and data sources included
- Interactive ease of use: Relates to the user interface
- Effectiveness, not efficiency: This relates largely to the way all DSS components were developed and the priorities used in the development process.
- Humans control the process: Relates to the user interface
- Ease of development by end users: Relates to the tools used to build models and to the end-user query facility of the database
- Modeling and analysis: Describes the models in the DSS
- Data access: Describes the database management capabilities of the DSS
- Stand-alone, integrated and/or Web-based: Reflects the way all components were developed

11. List some internal data and external data that could be found in a DSS for a university's admission office.

Internal data: Capacities of various majors for new students, historical success rates of applicants with specific characteristics, amount of money available for different forms of financial aid, team needs for specific types of athletes, agreed cutoff criteria for factors such as SAT scores.

External data: SAT scores and high school academic records of individual applicants, average grades given at various secondary schools

12. Why does a DSS need a DBMS, a model management system, and a user interface, but not necessarily a knowledge-based management system?

The database management system is required to store and retrieve the variety of data required by a DSS. The model-management system is required to provide the capabilities to analyze the data. The user interface provides a mechanism for the user to be able to interact with the DSS. All these capabilities are necessary; none can be dispensed with. The knowledge-based management system, by contrast, provides knowledge or expertise that might also be provided by an experienced user or, possibly trading off decision quality for system cost and complexity, dispensed with entirely.

13. What are the benefits and the limitations of the AIS SIGDSS classification for DSS?

The benefits of any classification are that, by grouping items that share common characteristics, one can benefit by knowing the common characteristics of each type rather than having to learn the characteristics of each item individually. The AIS SIGDSS DSS classification provides these benefits in a concise way by focusing on the key factor that drives each type of DSS.

The limitations of this classification are that any broad grouping of items must of necessity ignore or gloss over differences among items within each category. Thus, this classification ignores issues such as whether a DSS is custom-built or ready-made, whether it is institutional or ad hoc, and other differences that can be important in many situations.

14. Search for a ready-made DSS. What type of industry is its market? Explain why it is a ready-made DSS.

The answer to this question will depend on the ready-made DSS that each student finds.

ANSWERS TO END OF CHAPTER APPLICATION CASE QUESTIONS

1. Explain why solving the empty container logistics problem contributes to cost savings for CSAV.

The container fleet of 700,000 is valued at $2 billion, second only to vessel fuel in terms of cost. Empty containers are wasted space, and reducing this has a large impact on spending and operational efficiency.

2. What are some of the qualitative benefits of the optimization model for the empty container movements?

It allows system activities in all regional centers to be well coordinated while still maintaining operational flexibility and creativity. Forecasting errors were reduced with this model, allowing CSAV's depot to maintain lower safety stocks. The generation of intelligent information from historical transactional data helped increase efficiency of operations. The MC Network Flow model helps optimize the repositioning of empty containers.

3. What are some of the key benefits of the forecasting model in the ECO system implemented by CSAV?

Reducing forecasting errors, allow for lower safety stock levels.

4. Perform an online search to determine how other shipping companies handle the empty container problem. Do you think the ECO system would directly benefit those companies?

Many companies can be found on the Web with reference to the empty container problem. In addition to CSAV, a Google search finds: Magellan, Maersk, and TransBaltic (to name a few) as companies grappling with the empty container

problem. Two big issues with empty containers are the cost (waste of space), and the problem of repositioning the empty containers on a ship. Also, since containers are usually leased, this raises the question of which to keep on board. There are many web sources describing strategies, heuristics, and intelligent systems that tackle these complex problems, so ECO is part of an industry-wide effort in applying intelligent systems to the empty container problem.

5. Besides shipping logistics, can you think of any other domain where such a system would be useful in reducing cost?

Many industries and services include complex logistics, including problems of scheduling, inventory management, routing, and work flow. These problems often require managing limited resources of various kinds, with the danger that sometimes resources will be underutilized and other times overutilized. The models and reasoning algorithms of a system like ECO can be applied to these problems as well.