Knowledge-based decision support systems and their future in Knowledge Management Systems

Jong Hun Kim, December 14, 2005

hun@mail.utexas.edu

University of Texas at Austin, School of Information

INF 385Q – Knowledge Management Systems
Introduction

It is true that the current society is moving toward knowledge-based society. Knowledge is a fundamental resource for developing a knowledge-based society and it can give competitive power to the society. Because of that, every organization faces changes and is required to adapt to the changes for its survival and growth. So many organization constructed knowledge management system to perform consistency and effective works. Because of the construction, Decision Support Systems (DSS) came in to the world. Can you imagine making good decisions without knowledge? It shows why Decision support systems should be based on knowledge. For today’s organization, computer-based decision support is essential. Every moment for making decisions, managers use a computer to get and process knowledge which is stored and processed by a decision support system. The concept of a DSS is quite broad. It has been built and studied for more than 35 years so it can take various forms and terms can be used in various ways. Therefore, in my research paper, I will focus on decision making, the basics of DSS and what is knowledge-based DSS. Then, I will review the relationship between DSS and Knowledge Management System, integration of them, and its future.

Decision making and Knowledge

What is Decision making?
We make decisions for every minute. For example, what menu we will choose for dinner, will we turn off a computer, which grocery store we will go, and so on. The
definition of decision in the dictionary is an administrative action and is generally made once it is put into the written record for communication to persons who are affected by it. In a classic view of decision making, the number of alternatives identified and considered then selected one of them as the decision. Computer-based systems can be very helpful to support decision making. For example, some recommend a particular alternative and explain the rationale underlying the advice (Holsapple and Whinston, 1996).

There are two important factors that influence decision making and the range of decision support needs and possibilities. A decision context is the first factor. It is quite simple and about setting in which a decision is made. It examined from several management levels such as top, middle, and lower management. Also it examined from emergent or established settings and the degree of concurrency.

Another factor could be decision types. There are many kinds of decisions because they are complex and confusing. Because DSS and KMS are both technologies to support decision making process for the type of semi-structured decisions, it is necessary to understand the structured, semi-structured, and unstructured types of decisions. The structured decision is concerned with how routine and repetitive process that produces. It can be treated as ordinary and commonplace. However, an unstructured decision is a proposition and it could be novel or remarkable. The final type of decision is semi-structured decisions. It may be the result from unable to be programmed. For example, it is knowledge about the number of items to be used is not known, can not be simply, and can not be produced. So it is highly instructed decisions when it contains emergent context, novelty, rareness, and a lack of knowledge. For semi-structured decisions, there
are some special technologies such as DSS, KMS, GSS, and CRM (Ellis and Fisher, 1994).

Decision makers need quick responses to events that take place at a continually increasing rate and they should incorporate an enormous amount of knowledge such as data, choices and consequences. Also they must have fast access to consistent, high-quality knowledge to compete.

We can think decision making in Simon’s decision making model. Simon described the decision-making process as consisting of three phases, intelligence, design and choice (Simon, 1986).

The following picture shows Simon’s decision making model and the relationship between steps.

(Summers, 1999)

Intelligence is the first phase in the process and is a period when decision maker is alert for occasions to make decision, preoccupying and concerning. During this phase, the decision maker is gathering data, identifying the objects, defining the problem, and validating data. After defining and identifying the problem, the decision maker has to begin the analysis to solve the problem. The second is design. In the design phase,
activities are gathering data, manipulating data, generating reports, and analyzing the alternatives. Design can involve the development of alternative ways of solving the problem. The decision maker could find that additional knowledge is needed.

The next step in the process is choice. In this step, the decision maker takes a look at the alternatives to ensure that the best decision is being made. It consists of analyzing the alternatives and choosing one for implementation. Also it is done in the fact of internal and external pressures related to the nature of the decision maker and the decision context. There comes a time when one must be selected for implementation. If the time is not reached, the decision maker might return to one of the two earlier phases to collect more knowledge, formulate alternatives, and evaluate them. Choice will include generating statistics and generating simulated results for the alternatives. Also the decision maker must understand the alternatives, make the choice, and explain the decision.

For knowledge and decision making, we need to consider “the knowledge-based view”. A decision could be not only a piece of descriptive knowledge but also a piece of procedural knowledge. So making decision could be making new knowledge which did not exist before. Therefore, it is possible to say decision making is a knowledge intensive behavior. Computer-based DSS combined various KM techniques to represent and process knowledge of interest to decision makers, including descriptive, procedural, reasoning knowledge (Holsapple and Whinston, 1996).

**Knowledge management**

There are different types of knowledge such as explicit or tacit and descriptive or procedural or reasoning knowledge. In general, knowledge has great interest by
organizations because it involves knowledge that leads to effective policies, practices and procedures. For effective and efficient use of knowledge, knowledge management is concerned about the representation and processing of knowledge.

Knowledge Management is a bigger concept than technology and it involves technology, but technology is definitely a part of knowledge management (Davenport and Prusak, 2000). In addition, Knowledge Management is the organization, creation, sharing and flow of knowledge within organizations. Also knowledge management can be described as a process with four parts that comprise a loop. Knowledge is created in the heads of people and it is captured, and then it is put on paper in a report and entered into a computer system, or some kind of library, or simply remembered. In the loop, Knowledge can be classified and modified. The classification can include the addition of keywords or indexing and modification can add context, background, and other things that make it easier to re-use later.

Because knowledge can be found, used, and shared by people in the organization when they need it, there are many information technology systems that can make and support more effective knowledge management such as transaction processing systems, management information systems, expert systems, decision support systems, and executive information systems. These technologies are catalyzing the knowledge management movement (Davenport and Prusak, 2000). At the side of organizational knowledge creation, KMS must support the acquisition that organization and communication of both tacit and explicit knowledge of employees. Also a KMS should support the creation, gathering, organization, and dissemination of knowledge.
Decision Support Systems

History of decision support systems

Decision support systems started in 1965 in the era of distributed computing. They have developed over the past three decades. Their origin is in simple model-oriented systems and now they are advanced multi-function entities. In the 1960’s, most of them were fairly based on powerful mainframe computers and a new type of information system came out. A new type of information system became practical, model-oriented DSS or management decision systems. Many interests and publishing paid attention to decision systems during the 1970’s. Business journals started to publish articles about management decision support systems and DSS. Also the point of view of decision support system changed to more elaborate computer-based systems. It could support production, promotion, pricing, marketing and some logistical functions. Four criteria, defined by Holsapple, were robustness, easy of control, simplicity, and completeness and still use to evaluate DSS (Holsapple and Whinston, 1996).

In the 1980’s, decision support system appeared to the world of academic where they could share, discuss, and exchange about DSS. The framework for Decision Support Systems was greatly expanded. There was a technology shift from mainframe-based decision support system to client and server-based decision support system in the 1990’s. DSS started to use relational database technologies and many organizations started to upgrade their network infrastructure. The range of DSS could be extended by popularization of the internet. The development of DSS will be accelerated by the internet and Web.
**Purpose of decision support systems**

What is the purpose of DSS? The answer could be quite wide. In general, the purpose is “to improve the decision making ability of managers (and operating personnel) by allowing more or better decisions within the constraints of cognitive, time, and economic limits” (Holsapple and Whinston, 1996). More specifically, the purposes of a decision support system are:

- Supplementing the decision maker
- Allowing better intelligence, design, or choice
- Facilitating problem solving
- Providing aid for non structured decisions
- Managing knowledge

(Holsapple and Whinston, 1996)

Supplementing the decision maker dictates that decision support systems should supplement one or more of a decision maker’s ability. In practice, this ability would involve analyzing, recognizing such as what happen if a company lost 10 percent of its market share and what are a company’s sales on this month.

Based on Simon’s decision processes, a decision support system requires better intelligence, design, or choice by facilitate decision making phases (Holsapple and Whinston, 1996). For intelligence, a decision support system should scan both internal organization and external environment. In the design phase, it could possibly generate and evaluate decision alternatives. DSS should take the form of offering advice to get maximize expected outcomes for the choice phase.

Decision support systems should help problem solving and make it more easy, smooth and fast. Also it should provide help for non structured decisions. Most decisions are structured decisions because many of decision support system is based on computers.
From the knowledge management, we could infer that decision support systems should help to manage knowledge. It could be accomplished by strengthening knowledge representation and processing.

The purpose of DSS, concisely defined by Holsapple, was to improve the ability of decision making by allowing more or better decisions within given time and economic conditions. When all of the above the purpose of DSS was understood, it might possible to get an idea what is the picture of putting together characteristics of DSS that we have expected a DSS to exhibit.

**Characteristics of decision support systems**

What is the best way to discover characteristics of decision support systems? I would say the answer is both comparing and contrasting with other major knowledge system. Comparison and contrast was accomplished by Holsapple. In his book, he documented basic five characteristics of decision support systems:

- A DSS includes a body of knowledge: it describes some aspect of the decision-maker’s world, specifies how to accomplish various tasks, and indicates what conclusions are valid in various circumstances.
- A DSS has an ability to acquire and maintain descriptive knowledge and other kinds of knowledge.
- A DSS has an ability to present knowledge in various customized ways as well as in standard reports.
- A DSS has an ability to select any desired subset of stored knowledge for either presentation or deriving new knowledge.
• A DSS can interact directly with a decision maker or a participant in a decision maker: it provides both a flexible choice and sequence if knowledge management activities.

(Holsapple and Whinston, 1996)

Additional characteristics of decision support systems could be a lot but concisely it uses data and models and it was used by managers when they solve semistructured or unstructured problems. Also it is used to support managers by providing ways to the effectiveness of decisions.

Components of decision support systems

The DSS would typically provide access to the sensitive analyses or provide suggestions on how to improve the analyses. It is a specific type of information system that has four components.

• Data management system: A DSS uses one or more data stores to provide relevant information to the decision support system. Some of them are maintained by the DSS itself and some are external data sources. Some database primarily used and maintained by another information system with its own database management system and some DSS applications may have no separate DSS database. The data is entered into the DSS as needed.

• Model management system: the model base gives decision makers access to a variety of models and assist them in decision making. It can include the model management system software that coordinates the use of models in a DSS.
Dialogue subsystem or user interface: it allows users to interact with the DSS to obtain information. The user supplies information to the DSS and commands the DSS using this subsystem.

Knowledge management subsystem: this is optional subsystem and can support any of the other subsystem or act as an independent component. Also it provides knowledge for the solution of the specific problem. (Mallach, 1994)

The above components could be considered to constitute the software portion of the DSS. The knowledge system is the key DSS components because it includes of all the relevant rules. The knowledge system could hold representations of descriptive, procedural and reasoning knowledge and then the problem processing system solves by drawing knowledge from the knowledge representations of the knowledge system.

**Requirements for building successful DSS**

When the decision maker makes a decision, there are many alternatives which can range from few to thousands. The decision maker needs to narrow the possibilities to a reasonable number. This can be made easier by using decision support system or information retrieval system. Actually, computers could help to accomplish it because “computers can judge alternatives and assist the decision maker in presenting the alternatives in a form that facilitates the decision” (Mallach, 1994).

Since decision making process is complex and confusing, DSS must satisfy the following conditions:

- Help to detect existing or incipient problems
• Help to model a problem situation in order to clarify it
• Provide the tools so that options can be considered
• Help with implementation of change and its review (Finlay, 1994)

There are many other conditions for becoming good DSS such as high performance, temporal reasoning, asynchronous events, uncertain or missing data, continuous operation, and focus of attention. High performance means that there is very short response to give supports at right time. Temporal reasoning is the ability to reason about time-dependent events, sequences and relationships. Asynchronous events should be possible for the system to be interrupted to process an unexpected or unscheduled event. The system should be able to recognize and appropriately process uncertain or missing data. Finally, focus of attention refers to the ability of the system to selectively focus its resources when a particularly significant event occurs.

All of the above condition must be considered before building DSS. And DSS developers should keep these conditions when they perform the DSS development process. Even though systems satisfy all requirements, they can not succeed if they do not have ability to provide users with the right information on time.

Limitation of decision support systems

Even the most well-designed decision support systems, can have some limitations. There are some innate knowledge management skills and talents that could not be incorporated in a DSS (Holsapple and Whinston, 1996). For example, we can not expect that DSS with human skills such as creativity, intuition, and imagination. A DSS can process when it possesses knowledge. A DSS is constrained by the kinds of knowledge
processing its software can perform. For example, if a DSS could not process reasoning knowledge, then the system might not be able to reason to response to user’s request. Capabilities of decision support systems are limited by the computer such as operating system and hardware. Many of DSS are designed to be narrow or quite specific for what they can accomplish. At the fundamental level, well designed decision support systems can not overcome a faculty decision maker (Holsapple and Whinston, 1996). Also there are some dangerous points which are related to DSS such as over dependence and blindly following.

What are knowledge-based decision support systems

To distinguish whether decision support systems are knowledge-based or not, it is good idea to explore knowledge-based decision support systems. Knowledge-based decision support systems integrate traditional DSS with the advances of expert systems. Generally, decision support systems constitute data management, modeling, decision methodology and display of numerical data, while the advanced expert systems embrace symbolic reasoning and explanation capabilities (Klein & Methlie, 1995).

Knowledge-based decision support systems should assist users in making strategic by presenting information and interpretations for various alternatives. For the development of current DSS providing interpretation of knowledge, there are three important approaches and each approach focuses on enriching some part of the aspects of the traditional decision support systems.

- Rule-based reasoning
- Case-based reasoning
Hybrid (a combination of Rule-based reasoning Case-based reasoning)

(Pal & Palmer, 2000)

If someone wants to define what knowledge-based decision support systems are in one sentence? The answer might be it is a decision support system with an expert system or intelligent component. Also it should provide some functions such as support problem recognition, support problem structuring, support access to relevant information, and support problem formulation and analysis.

Relationship between DSS and KM

In the previous part, we look over DSS and KM separately. So at this point, we need to explore them together. If someone asks me about relationship between DSS and KM, I might say that DSS and knowledge management are interdependent activity because effective DSS can be made with process and facilities that support the use of knowledge management.

As we know, in the decision making process, decision makers combine different types of data and knowledge in various forms in the organization. The decision making process try to improve understanding of the problem and making new knowledge. It means the decision making and knowledge creation are interdependent.

In general, proper integration of DSS and KMS will support the required interaction. Also it will make new opportunities for enhancing the quality of support to each other system. Therefore, when they combined, the effect of synergy might be created through the integration of DSS and KM. We could infer it from “The knowledge acquisition, storage and distribution activities in knowledge management enable the dynamic creation and maintenance of decision models, in this way, enhancing the decision
support process” (Holsapple and Whinston, 1996). If integration happened, we can expect enhancing the quality of support by the system and helping to build up organizational memory and knowledge bases.

To go further discussion about relationship between DSS and KMS, it is necessary to look over Nonaka’s theory. In his book, the knowledge-creating company, he proposes that new organizational knowledge is created by a dialectical relationship between tacit and explicit knowledge. Also it emerges into a spiral of knowledge creation consisting of four types of knowledge conversions: socialization, externalization, combination, and internalization. The following picture shows Nonaks’s conversions and their relationship.

(Nonaka and Takeuchi, 1995)

According to Nonaka, the knowledge externalization involves the conversion of tacit knowledge to explicit knowledge. In the context of DSS, this might be similar to the process of decision making that involves elicitation of problem-solving knowledge from the decision maker and its presentation.
Similarities between DSS and KMS can be found in the combination type of knowledge conversion. It generates new explicit knowledge from existing explicit knowledge and the process of model integration in DSS. Knowledge internalization corresponds to the adoption and use of explicit organizational knowledge by individuals. It can be compared to building DSS using elicited decision models.

The socialization type of knowledge conversion may be considered as analogous to sharing information pertaining to decisions made by different decision makers (Nonaka and Takeuchi, 1995). Therefore, we can infer that the interaction between the DSS and KMS might include the application of explicit knowledge created for future decision making and building DSS and the generation of new knowledge by using of DSS.

**Future of DSS**

Current states of DSS provide a wide range of capabilities. Computerized systems support decision making like information gathering, model building, sensitivity analysis, collaboration, evaluation and implementation. Also DSS are integrated in business decision processes and the primary enabling technology for delivering decision support is the Internet and the WWW.

Web technologies, support DSS, can provide platform independent, remote, and distributed computation and the exchange of complex multimedia information (Power, 2002). Also they can promise to improve the quality, speed and effectiveness of specific decisions. To maximize benefits from DSS, all information system will be combined into an integrated whole using new technology. As we know that an intelligent is a new technology with the potential to perform a set of operations on
behalf of the user or another program with independence or autonomy, an intelligent component will be combined into DSS to increase its functionality.

There are DSS challenges. The first is understand the relationship between data, information, and decision making such as what decisions need to be made, availability of data and information for decisions. The second is design and integrate software systems to make effective use of available data such as integration, data control, and, interface (Holsapple and Whinston, 1996). To eliminate or minimize challenges, the speed of interrelating and interaction between DSS and KMS will significantly increase in any organization because integration of DSS and KMS will make some chances to meet several benefits which can not be realized with any one system.

**Conclusion**

In the previous part, we looked over the fundamental of DSS and KM. Then we tried to find their relationships and integrated them. The result from integrating DSS and KMS could make some benefits. It can enhance quality of support provided to decision makers in the direction of real time adaptive active decision support and facilitate discover of trends and patterns in the accumulated knowledge. Also it can support to build up organizational memory and support knowledge management functions such as acquisition, creation, exploitation, and accumulation.
References


