COMPUTER-BASED DECISION SUPPORT SYSTEM USE IN CONTRACTING'S SOURCE SELECTION PROCESS

THESIS

Matthew L. Decker
Captain, USAF

AFIT/GIR/LAS/98S-1

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GIR/LAS/98S-1

COMPUTER-BASED DECISION SUPPORT SYSTEM USE IN CONTRACTING'S SOURCE SELECTION PROCESS

THESIS

Matthew L. Decker
Captain, USAF

AFIT/GIR/LAS/98S-1

AFIT/GIR/LAS/98S-1

COMPUTER-BASED DECISION SUPPORT SYSTEM USE IN CONTRACTING'S SOURCE SELECTION PROCESS

THESIS

Presented to the Faculty of the Graduate School of Logistics

and Acquisition Management of the Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Information Resource Management

Matthew L. Decker

Captain, USAF

September 1998

Acknowledgements

This thesis would not have been possible without the support and concern of my wife, my thesis committee, and my classmates. Their help was instrumental in my completion of this effort.

I cannot adequately thank my wife, Carina, for the support and motivation she provided me. Her unwavering love and understanding during this sometimes frustrating effort was a blessing that I am truly thankful for.

To my thesis advisor, Major Caisse Vickery, who had to put up with my varying motivation: I thank you very much for taking the time to guide me through this effort. By allowing me to progress at my own speed and down my own path with only infrequent refocusing, you enabled me to learn a great deal about this subject matter, the academic process and about leadership. Your availability and obvious concern for me as a person is greatly appreciated. I am also indebted to my reader, Major Michael Morris, who greatly assisted the improvement of the final product.

I also must thank my classmates and friends who were there to distract me, set my priorities straight, and help me enjoy it all.

Captain Matthew L. Decker

Table of Contents

Page

Page

List of Figures

List of Tables

AFIT/GIR/LAS/98S-1

Abstract

This thesis examines the use of decision support system (DSS) technology within the U.S. Air Force's contracting source selection process. DSS technology has been shown to be an effective aid to complex decision processes such as source selection decisions and the possible effects of utilizing this technology are the focus of this study. Conclusions drawn from this thesis may guide the contracting community to readdress the possibility of implementing DSS technology within the source selection process.

This study evaluated statistical data from a previous experiment to determine the effect of DSS use on time, confidence, and decision quality. This study also included interviews of individuals involved in the source selection process to determine their perceptions of DSS technology. It was found that the perception of DSS technology within the source selection community has improved within the last five years. It was also found that source selection experts foresee DSS implementation within the source selection process within the near future. In fact, the source selection experts interviewed believed that group DSS would provide the greatest benefit to the process. Possible explanations and implications of this discovery are provided.

COMPUTER-BASED DECISION SUPPORT SYSTEM USE IN CONTRACTING'S SOURCE SELECTION PROCESS

I. Introduction

General Issue

The ability to make optimal decisions is an important aspect of all human existence. Whether it be the decision of what to plant in the fields, what type of insurance to buy, or what technological applications to purchase, decisions represent the important choices in life. The decision making process can be defined as the steps the decision maker goes through in preparation of reaching a decision.

Obviously, the decision process has a great impact of the eventual decision. For example, if the decision scenario was to choose what car insurance to purchase, there would be several decision-making processes that could be utilized. The decision-maker could select the insurance policy with the nicest brochure or could follow a systematic and complete decision process. Which decision process would you prefer using to select your insurance coverage? How we reach a decision greatly impacts the ultimate decision reached so we should strive to improve how decisions are made in order to improve the resultant decision.

Since the decision making process is so vital to better decisions, it is not surprising that a significant amount of academic literature has been developed addressing this area. Herbert Simon is widely considered to be the grandfather of decision theory and is considered the most well known and accepted of the decision theorists. He has created an increased understanding of the decision process and how to improve it.

The emphasis on decision making and decision theory has also progressed from the academic to the business community. At an organizational level, improving decision making is seen as a way to increase competitiveness and improve the profit margin. Because of the perceived monetary benefit of improved decision making, significant investments into this field have been made.

The Department of Defense (DoD) has also pursued improved decision making through a variety of methods. A fairly recent development in the decision-making arena is the usage of computers to aid in the decision process. There have been, in recent years, developments of computer-based decision aids that facilitate complex decision-making. This study will address the applicability of this technology in a specific decision making process within the Department of the Air Force, namely the source selection process.

The source selection process is a process by which the United States Air Force chooses between alternative suppliers to perform a service or, most commonly, to provide a product or weapon system. The individual who has the responsibility to reach this contract award decision is the Source Selection Authority (SSA). This goal of the decision process is to provide the "best value" to the Air Force. The best value concept includes aspects such as utility, quality, cost, and risk. It frees the decision maker from the previous heuristic of selecting the lowest cost proposal and allows him to reach his own decision based on the breadth of data. A Source Selection Evaluation Team (SSET) assists the SSA in gathering and consolidating information.

The decision scenario is a complex one with several competing factors and decision criteria. The decision-maker (SSA) is tasked with sorting through the great amounts of information, analyzing it, and determining the best value for the Air Force. With such a formidable task, decision-makers can become overwhelmed with the task and can, in turn, oversimplify the decision through the omission of factors relevant to the decision. If these decisions are made without taking into account all the relevant information and comparison factors, it is very likely the decisions will be less than optimal. In other words, the best value proposal may not be selected for contract award. The repercussions of not selecting the best value proposal could be a weapon system that does not provide the capability the warfighters need to accomplish their mission. Money could be wasted and people could die as a result of a poor source selection decision. With so much on the line in a complex decision scenario, all possible aids should be provided to the SSA to enable him to effectively analyze the information, compare decision factors and reach the best value decision. One of these aids is the decision support system (DSS).

DSS technology has been available for a number of years. There are a number of commercial providers of DSS software that could, with minimal changes, support the specific source selection decision process. The technology is available and the source selection process could possibly benefit from the implementation of DSS technology.

Specific Problem

The source selection process tasks the SSA with reaching an optimal decision addressing numerous decision factors and a plethora of information. Studies by George Miller have shown that humans can "distinguish between only about seven choices, plus or minus two" (Miller, 1956: 84). Given the limitations of humans as information processors, perhaps this process could be improved with an information processing and decision aid like a DSS.

The purpose of this study is to determine the impact of using a DSS to arrive at a source selection decision. Provided this quantitative information, the following question must be addressed: given the available technology and its detailed impact, could DSS technology improve the source selection process? This question includes not just the impact of DSS on decision factors but must also take into account broader issues like technology as a barrier, the corporate culture, potential personal resistance, and perception problems. This research question will be broken down in this study and addressed as a grouping of several research questions. They are listed below:

How does DSS technology affect key decisional factors such as time, confidence, and quality?

Have the perceptions concerning DSS technology changed within the last five years?

How will DSS technology affect the satisfaction with the source selection decision process?

How will DSS technology affect the alternatives considered prior to reaching a decision?

Do individuals involved in the source selection process foresee DSS technology being implemented in the decision process?

The source selection decision process is a complex process demanding almost superhuman capabilities from the SSA. The amount of information that must be considered and the number and complexity of the decision factors is immense. Since DSS have shown to capable facilitators of complex decision processes, the natural conclusion would be to implement DSS technology into the process. This study will attempt to determine the impact of DSS technology on the source selection decision as well as ascertain the perceptions of this technology within the source selection community.

This study will address these research questions by first providing a background of the research areas relevant to this study in a thorough review of the available literature. A description of the hypotheses to be tested in this study and how they will be tested is included in Chapter III, Methodology. Chapter IV describes the results of the hypothesis testing and the Conclusion summarizes the impact of the results.

II. Literature Review

Introduction

Decision-making is the choice between alternatives and is an integral part of all aspects of human life. Decision-making involves gathering information, processing it, comparing alternatives, and choosing between the alternatives (Barr and Sharda, 1997: 133-134). It is something we all do regularly.

A Decision Support System (DSS) is a system of rules designed to aid in the decision making process. This discussion of DSS will focus on computer-based DSS, where the rules are programmed in the software. The DSS does not make the decision for the user but instead is a tool used to assist in the compilation and comparison of alternatives. The ultimate decision rests with the individual user (Barr and Sharda, 1997: 134). This thesis documents the examination of whether DSS usage could improve the source selection decision process and provides a framework for further investigation into the feasibility of using DSS to assist in the source selection decision process.

The source selection process is an established governmental process that chooses between different contractor's proposals. The process begins when needs are identified by the government and Requests For Proposal (RFP) are made available to potential contractors. Contractors reply to the RFP with their complete technical, contractual, and cost solution. The proposals are then examined according to the "technical, financial, and economic or business considerations consistent with the requirement [RFP] and business and legal constraints" (AFFARS Appendix BB, 1997: 2). The governing regulation for source selection decisions also allows for the possibility of utilizing a computer-based DSS when it states "each member [of the process] shall be given access to the full range of evaluation tools available" (AFFARS Appendix BB, 1997: 7).

DSS use has shown to affect several aspects of the decision process with other decision types and perhaps these positive results will also be seen with DSS use in the source selection decisions (Eierman et al., 1995: 8). While DSS use has no significant affect on the time required to make the decision, it has shown to increase the number of decision alternatives considered, increase decision confidence, and increase decision quality (Eierman et al., 1995: 8-17). The research question for this proposal is whether these effects discovered in the literature will also be seen with DSS usage in the source selection decision process. More specifically, the research question is whether DSS use in the source selection process will have no effect on time required to make a decision, increase the number of decision alternatives considered, increase decision confidence, and increase decision quality. To address this research question, we will address how decisions are made, what factors are affected by DSS usage, source selection decisions, and hypothesize a result when DSS are used in source selection decisions.

The source selection decision process could benefit from the introduction of DSS to the process (Vickery, 1989: 3). The fact that DSS usage increases the number of alternatives considered increases decision confidence, and increases decision quality proves important to this study (Eierman et al., 1995: 8-17). Since these decisional factors are also important to the more specific source selection decision, this thesis will address whether the same relationship exists between DSS usage and improvement in source selection alternatives considered, confidence, and quality.

Summary of Current Knowledge

To effectively investigate this question, this literature review will address three main areas. First, the factors affecting good decisions will be defined. Secondly, DSS will be defined and the effects of DSS usage on decisions will be addressed. Finally, the literature review will define the source selection process and look into the possibilities of DSS usage in this decision scenario.

Decision-Making

Decision-making has been understood as an integral part of human existence for some time and decisions have generally been classified into two categories, programmed and nonprogrammed (Simon, 1977: 45). Simon describes programmed decisions as:

> Decisions are programmed to the extent that they are repetitive and routine, to the extent that a definite procedure has been worked out for handling them so they don't have to be treated *de novo* each time they occur. (Simon, 1977: 46)

Simon describes nonprogrammed decisions as:

> Decisions are nonprogrammed to the extent that they are novel, unstructured and usually consequential. There is no cut-and-dried method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment. (Simon, 1977: 46)

It is important to note that the research indicates these two decision types are not mutually exclusive, but that decisions generally have characteristics of both. Simon describes this by stating, "The distinction [between programmed and nonprogrammed] will be a convenient one. I shall use it... hoping that the reader will remind himself from time to time that the world is mostly gray with only a few patches of black and white" (Simon, 1977: 47). This is important since both of these extremes, programmed and nonprogrammed, could not effectively apply DSS technology. Programmed decisions would not require extensive decision-making capabilities since a heuristic could be developed and applied to every decision since they are all the same. Nonprogrammed decisions would be so novel that it would be extremely difficult to develop a new DSS for every decision. DSS technology applies to the decision in this "gray area."

The source selection decisions to be addressed in this study can be described as between programmed and nonprogrammed, in the "gray area" as Simon called it. These decisions are programmed to the extent that they are repetitive and recurring. For example, the source selection decision process is common within the contracting arena and the goal of every source selection is the same, best value (AFFARS Appendix BB, 1997: 3). In this respect, the source selection decision is programmed. Source selection decisions are nonprogrammed to the extent that they produce a consequential decision and there is no one way to solve all source selection decisions. The source selection process decides which companies the military will do business with. These decisions could have far-reaching consequences in our national defense. These decisions are also nonprogrammed because there can be no one formula for computing the best value of different source selection proposals. It is different every time. The blending of programmed and nonprogrammed decision type characteristics within the source selection decision process lead it to be classified as a combination decision type.

DSS has been found to add structure to the decision-making process. The added structure of a DSS could alter the decision type, in effect pushing the decisions more toward the programmed extreme. Decisions previously classified as nonprogrammed may, with the structure of a DSS, become combination decision types.

The Rational Model

The rational model was one of the first models to describe how decisions are made. It is composed of three phases, intelligence, design, and choice (Simon, 1977: 40). During the intelligence phase, data is gathered on goals, objectives, and alternative courses of action. The design phase is where the decision-maker designs the method by which the alternatives will be evaluated. Finally, the decision is made in the choice phase.

The rational model represents an idealistic approach which assumes that all the relevant information needed to make a decision is available, and that the decision-maker is rational and able to interpret all of the information. The result of this model is the optimal decision. In order to reach the optimal decision, a completely rational decision-maker must base his decision on perfect knowledge of all the alternatives (Simon, 1976: xxviii). Hogarth 1987 also describes the optimizing process as "choosing the best of all possible alternatives" (Hogarth, 1987:65). This involves assessing every possible alternative according to costs and benefits and selecting the rational alternative.

Given the human information-processing limitations, optimizing is a difficult goal to achieve. Simon questioned this model in the 1950's when he showed that human information-processing limitations preclude rational investigation of all possible alternatives (Simon 1955: 69).

Problems with the Rational Environment

There are several reasons why the rational model is not a true representation of how humans make decisions. They are based on the innate limitations of the human mind that prevent decision-makers from making a rational choice. Hogarth 1987 lists four reasons for the existence of the disparity between the rational model and how decisions are actually made. These reasons are; randomness and the probabilistic environment, information issues, limited resources, and bounded rationality (Hogarth, 1987: 204-205). The following section will first discuss the innate human information-processing limitations and then address Hogarth's four points individually.

Information-Processing Limitations

Miller 1956 proposed a theory on the limitations of the human mind called the "magical number seven." Miller believes that the human judgement and short-term memory limits the amount of information we are able to receive process and remember. Studies conducted by Miller showed that people were able to distinguish between only about seven choices, plus or minus three (Miller, 1956: 84). This shows an innate human information processing limitation that could influence the decision making process. Since decision quality has been positively correlated with the number of alternatives considered in reaching the decision (Cats-Baril and Huber, 1987: 368), humans could make better quality decisions with the processing assistance of a computer-based DSS. The DSS enables the decision-maker to distinguish between more than seven plus or minus two choices.

The main process that appears in the literature to describe how humans, with their information and processing limitations, actually make decisions is satisficing. Satisficing is finding a decision that is a "satisfactory alternative" and this approach is a more accepted decision-making approach than optimizing (Hogarth, 1987:65). Since every possible alternative cannot be assessed rationally according to the cost-benefit analysis, the decision-maker settles for a decision that is acceptable, though it may not be the optimal decision. Simon states that decision-makers satisfice by relying on habit or established routines for decision making (Simon 1977: 48). The theory of bounded rationality explains how decision-makers cope with the complexity of the decision making process. Satisficing allows for the limited information-processing capabilities of the human mind.

Randomness and the Probabilistic Environment

Humans have difficulty dealing with the uncertain environment we live in and in order to cope, humans are apt to believe that the environment is probabilistic instead. Hogarth states that "the world is perceived by us as being probabilistic since we are unable to see and comprehend the myriad factors that cause events to occur" (Hogarth, 1987: 12). This inability to understand the world around us is based on our limited information-processing capabilities and leads us to seek out patterns and probabilities of things we observe. The human tendency to perceive the environment as being probabilistic goes against the rational model because in the rational model we would have perfect information and understanding and not be relegated to approximating false probabilities.

Information Issues

Difficulty with processing large amounts of information leads people to take shortcuts in the judgement and choice stages of the decision-making process prohibiting their attainment of the rational model. Examples of these are the availability heuristic and the anchoring and adjusting heuristic. The availability heuristic states that decision-makers are likely to base their decisions on information that is readily available (Tversky and Khaneman, 1973: 208). Simply put, Tversky and Khaneman state that, contrary to the rational model, the availability heuristic "uses strength of association as a basis for the judgement of frequency" (Tversky and Khaneman, 1973: 208). This greatly limits the information search and falls far short of the rational model's "perfect information" constraint (Hogarth, 1987: 53).

People make estimates by starting from an initial value that is adjusted to reach a final answer (Tversky and Khaneman, 1974: 1127). These "adjustments are typically insufficient" and "different starting points yield different estimates, which are biased toward the initial values" (Tversky and Khaneman, 1974: 1127). The anchoring and adjusting heuristic deals with the propensity of decision-makers to rely on available information (availability heuristic) and arrive at a preliminary starting point. Information that is gathered and processed after the anchor has been set will cause only minor adjustments to the original anchor (Hogarth, 1987: 54). This heuristic also prevents humans from arriving at a truly rational decision. The two heuristics described above deal with the two main points of information issues as describes by Hogarth, information availability and information processing. The availability heuristic shows how humans use only information that is easily available, precluding the attainment of perfect knowledge as the rational model suggests. The anchoring and adjusting heuristic explains how humans, unable to process all the information, anchor early in the decision process and tend to adjust only slightly from there. This is also contrary to the rational model.

Limited Resources

A limitation on essentially all decision processes is limited resources (Simon, 1982: 67). These resource limitations may be time or budget constraints within which the decision-maker must reach a decision. This situation of limited resources makes it extremely difficult for the decision-maker to gather all the relevant information, process it completely, and make a rational decision as purported by the rational model. We all face limited resources when confronted with a decision process whether it is time or money and this limitation makes the rational model difficult if not impossible to follow.

Bounded Rationality

Simon developed the theory of bounded rationality. He states that the increasing complexity of decisions "has stimulated the development of new kinds of models of rational decision that take special account of the very limited information-gathering and computing capacity of human beings" (Simon, 1982: 423). In his book *Judgement and Choice*, Hogarth also discusses the theory of bounded rationality. This states that "rational choice requires having both much information at one's disposal and impressive computational capacity" (Hogarth 1987: 64). He goes on to state that no one has "probably ever made a choice of any consequence involving all the elements of the rational model" (Hogarth 1987: 64). In order to cope with the complicated nature of decision problems, humans reduce the scope of the problem resulting in decisions that can be called reasonable but not rational (Hogarth, 1987: 65). Humans reduce the scope of the problem by imposing constraints that are not part of the problem but make the decision process more understandable. The human mind is able to neither gather all the information nor process it rationally.

The literature review of decision-making details many important aspects of how humans make decisions and how this decision-making rarely, if ever, follows the rational model. The original goal has been the rational decision. It is important to note that decision quality has been shown to improve to the extent that humans are able to approach the rational model, gather all the available information, process it, and rationally select the best alternative (Simon, 1976: xxviii). The rational model is the goal. Rational decision-making has also been shown to be an impossible goal given the satisficing process, Miller's "magical number seven," and Hogarth's four points. To improve the decision process and get closer to the goal of rational decision-making, computer's information processing capabilities could moderate the above-noted concerns. The computer effect could supplement the human mind and increase the rationality of the decision-making process. The mitigating effect of DSS on several of these points could improve the rationality of the decision process. An example is the ability of computers to process and compare large amounts of information could mitigate the effects of our innate information-processing limitations. Another example of this is how the decision-making structure programmed into the DSS could lessen the reliance upon the heuristics described by Simon and Hogarth, thereby increasing the rationality of the decision process.

Decision-Making Model

Mintzberg et al. 1976 developed a model for decision-making based on three stages: identification, development, and selection (Mintzberg et al., 1976: 266). A simplified model of decision-making, based loosely on Mintzberg's model, is in Figure 1.

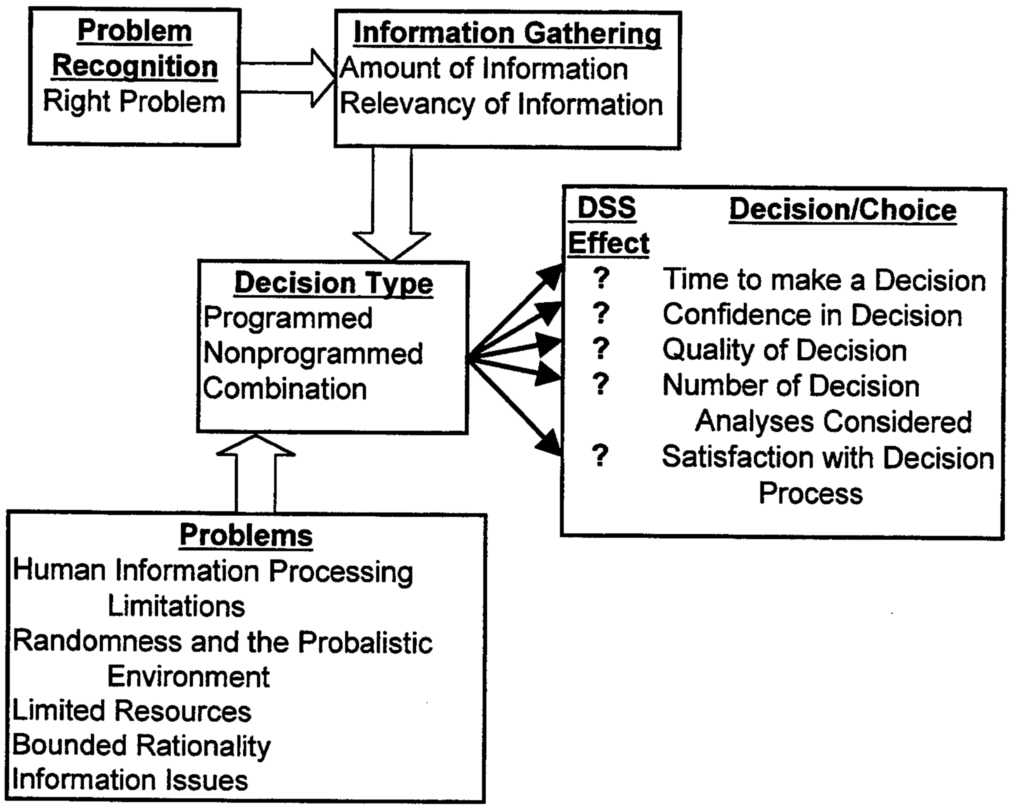

Figure 1. Decision Process Model

The model depicted above shows the decision-making process as it will be discussed in this study. The decision process begins with problem recognition. During this phase, the realization is made that a decision on the subject is needed. The main question that needs to be answered in this phase is whether what is the root problem to be studied. Though this seems rather simple, it is a critical and often difficult stage in the decision-making process. In source selection decisions, this stage is straightforward since the problem is always known and stated, namely, finding the 'best value' proposal.

Once the problem is recognized, the information-gathering phase begins. During this phase, information on previous similar decisions is gathered as well as specific information on this particular decision. Two important factors in this stage in the process are whether enough information has been gathered to approach rationality and whether the information gathered provides adequate subject knowledge. In the source selection decision process, the SSET and not the decision-maker (SSA) complete the information gathering. The information-gathering phase is structured to the extent that each proposal must address the complete list of topics presented in the RFP.

From this information, a determination of the type of decision can be made. Source selection decisions, as addressed above, fall into the combination category. This category contains aspects from both programmed and nonprogrammed decision types and is able to be supplemented by DSS technology.

The final step is the decision/choice stage. Once the background information is gathered, a decision must be made. Factors of the choice phase, and listed in the decision/choice box above, include time, confidence, quality, number of decision analyses considered, and decision satisfaction. The time required to make a decision is important because of the limited resources we all operate under. Confidence and satisfaction with the decision are important factors to the decision-maker and tell about the decision-maker's perceptions of the decision process. Decision quality is the ultimate goal. It can be described as the degree of rationality. The best decision will be the rational one and decision quality increases to the extent that we approach rationality. The more decision analyses addressed in the decision-making process the closer we get to approaching the rational model's goal of looking at all alternatives. All of these are factors of the decision and will be used to assess the decision itself. This model will be used throughout this study to visually describe the decision process.

Decision Support Systems

Computers do not have the same restrictions and limitations as humans with respect to the amount of information they are able to process. Thus, they may help the decision-maker efficiently process the large amounts of information, compare alternatives, and therefore reach an optimized decision. "Advances in information retrieval, processing, and display technologies have certainly led to computer programs that help people perform management functions. Since the purpose of these systems is to support managers responsible for making and implementing decisions rather than replace them, these applications are called Decision Support Systems (DSS)" (Alter, 1980: 1). Barr and Sharda 1997 describe DSS by stating "DSS's major value is in removing information overload and redundancy by summarizing, categorizing, and projecting important data, thus decreasing the cognitive effort required to process large amounts of information and allowing decision-makers to focus on more central elements and issues in the decision process" (Barr and Sharda, 1997: 134).

The DSS supports the processing of information and comparison of alternatives and leaves the actual decision up to the decision-maker. DSS are suited for programmed decisions and decisions in the "gray area," as Simon called it, between programmed and nonprogrammed decision types. DSS are regularly used in programmed decisions since these problems are routine and repetitive and a DSS can be developed to automate the decision process. An example of this is a credit approval system. Pertinent information is entered into the DSS (income, debt, etc.) and the DSS determines the credit line by comparing several alternatives. Nonprogrammed decisions are so novel that they defy DSS development (Keen, 1980: 27). It is generally considered not worth the time required to construct a DSS for one decision that will not be repeated. Semi-structured tasks allow for a combination of human judgment and computer capabilities (Keen, 1980: 27).

DSS can be added to the decision process model discussed above. Once the decision type is assessed, a determination of the benefits of adding a DSS can be made. If a DSS is used in the process, it could impact several factors in the decision/choice stage. The introduction of DSS is depicted in the model below.

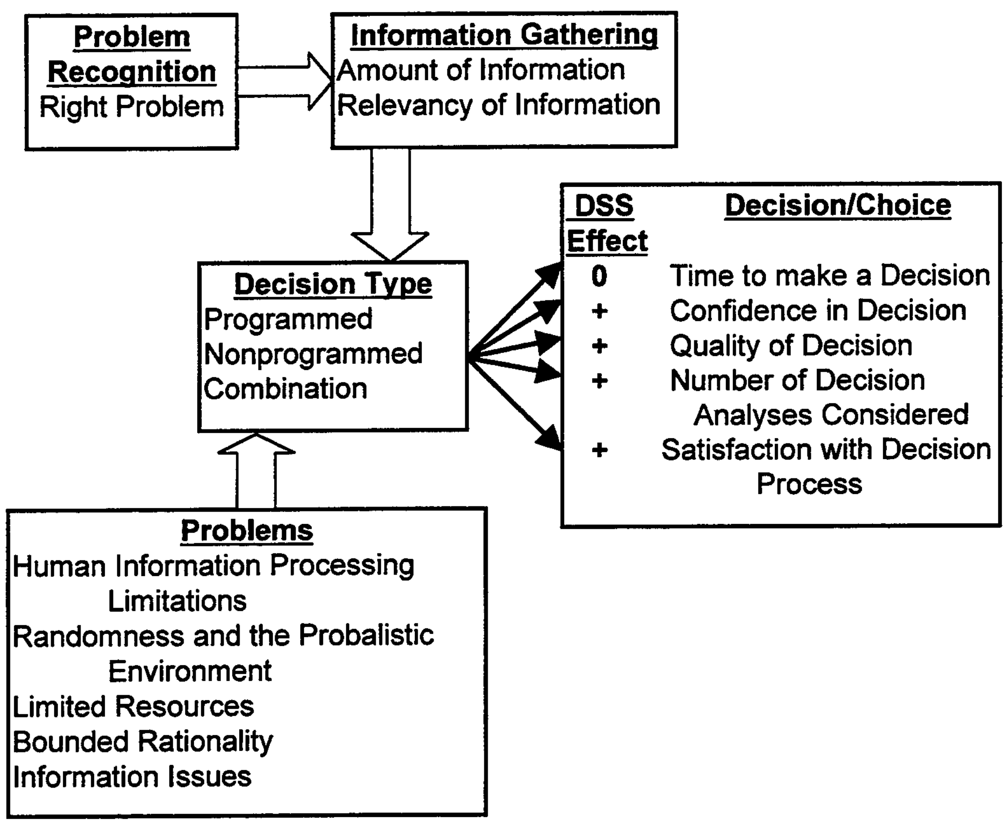

Figure 2. Decision Process Model with DSS Effects

The question is how the introduction of a DSS into the decision process influences the decision. The impact of using a DSS on certain factors in the model will be addressed in the following section.

DSS Effect on Decision Factors

DSS effectiveness has been evaluated in many studies. The research indicates that DSS usage affects several factors in the decision process. The following literature on DSS shows the relationships between DSS usage and several independent variables. The variables addressed include time required to make a decision, the number of alternatives addressed, confidence in the decision, satisfaction with decision, and decision quality.

Time to Make a Decision

DSS use is new to many of the subjects tested in the literature and therefore, the learning curve effect is seen in the majority of studies done over time. Barr and Sharda 1997 stated that DSS use leads to "decreased time spent in processing information... by letting decision-makers focus on strategic issues" (Barr and Sharda, 1997: 134). In other words, the DSS assists in simplifying and speeding the decision process by decreasing the "cognitive effort required to process [the] large amounts of information" (Barr and Sharda, 1997: 134).

Another study by Sharda et al. discovered that in the first three periods of use, the time required to make a decision for those using DSS was significantly greater than for those who did not use a DSS. From the fourth period of use to the end of the study, the differences in time required between the two groups became insignificant (Sharda et al., 1988: 153). Mackay et al.'s study revealed similar results. It found that novice DSS users took significantly longer than decision-makers not using the DSS. This study also found that experienced DSS users required significantly less time to make a decision than the novice DSS users (Mackay et al., 1992: 660-663). The time factor seems to follow the learning curve, whereby originally decisions with DSS take longer than those without but this difference disappears after the subjects have become accustomed to the new technique.

Confidence in Decision

Most evidence in the literature concerning decision confidence shows that use of a DSS has a slight positive effect. While a study by Cats-Baril and Huber showed no significant difference in decision confidence between DSS users and non-users (Cats-Baril and Huber, 1987: 370), Sharda et al. found a slight increase in confidence with DSS usage (Sharda et al., 1988: 154). A study by Schroeder and Benbasat found that since DSS users processed significantly more information that non-DSS users and believed a positive relationship existed between the amount of information and the confidence in the decision, they would have greater confidence in the DSS decisions (Schroeder and Benbasat, 1975: 564). A study by Barr and Sharda 1997 stated that DSS's ability to summarize, categorize, and project data decreased the cognitive effort required and "increased the confidence in the decision" (Barr and Sharda, 1997:134).

Decision Quality

Decision quality is defined as the ability to reach the optimal decision. Increasing decision quality is the most significant impetus for using a DSS. The results on DSS's influence on decision quality vary a great deal. Sharda et al.'s study noted significantly greater decision-making performance by people using a DSS when compared with those who did not (Sharda et al., 1988:155). This study was composed of eight separate periods of DSS use with measurements of decision quality taken for each period. It is interesting to note that the significant differences in decision quality between the DSS group and the non-DSS group was not realized until the fourth period. This gives credence to the learning curve effect. From the fourth period on, the differences were significant, as was the overall difference. Cats-Baril and Huber's study on DSS showed no significant difference in decision quality between DSS groups and non-DSS groups (Cats-Baril and Huber 1987: 363). A possible explanation for this is the fact that this study measured only one period and did not allow for the users to progress along the learning curve.

Eierman et al.'s compilation of DSS research discovered a positive impact on decision quality. He states, "results from those studies comparing a 'DSS' treatment with a 'no DSS' alternative show that... DSS can have a positive impact on performance [decision quality]" (Eierman et al., 1995: 10-11). Barr and Sharda 1997 also supported these results. They stated that "numerous studies have documented improvements in quality of decision outcomes through introduction and use of DSS" (Barr and Sharda, 1997: 133). The continue by stating that "laboratory studies employing 'objective' measures of decision performance and using repeated measures did indicate that DSS availability could be expected to increase decision quality" (Barr and Sharda, 1997: 135).

Decision Analyses Considered

It is consistently noted in the literature that decision-makers using DSS address more alternatives than decision-makers not using the system. Cats-Baril and Huber noted in their study that DSS "enhanced productivity more (generated higher number of objectives and alternatives) than passive aids. Since high productivity of ideas has been correlated with larger numbers of high-quality ideas, the... interactive presentation [DSS] appears to provide the most effective support in terms of achieving decision quality" (Cats-Baril and Huber, 1987: 368). A study by Sharda et al. also found that users of DSS investigated more alternatives than those who did not use the DSS (Sharda et al., 1988: 154). A third study by Mackay et al. supported the previous studies by stating that users of DSS "pursued a greater number of activities in these steps [problem finding and problem solution], reflecting the ability of a decision-aided problem solver to examine more efficiently a larger set of alternatives" (Mackay et al. 1992: 665).

Barr and Sharda's 1997 study supports the increase in decision alternatives considered with DSS use. They state "the use of 'what-if' or Monte Carlo analyses, common in many DSS, allows the decision-maker to evaluate numerous courses of action and to develop an increased understanding of how decision factors affect other input and outcome variables" (Barr and Sharda, 1997: 134). They also conclude that by removing information overload, DSS use "lead[s] to such benefits as examination of more alternatives" (Barr and Sharda, 1997: 134). Wierenga and van Bruggen 1998 also support the previous literature. They state that the use of DSS will "result in greater number of ideas" (Wierenga and van Bruggen, 1998:84). Since the rational model centers on a comparison of all possible alternatives and the goal is to approach rationality in decision-making, the more alternatives addressed in the decision process the closer to the rational model.

Satisfaction with Decision

Another important aspect of a decision is the satisfaction with the decision process. The literature found a negative effect on satisfaction with DSS usage. Decision-makers who used DSS "were less satisfied with the overall process" than decision-makers who did not use DSS (Cats-Baril and Huber, 1987: 364). The Cats-Baril and Huber study found that subjects using the DSS reacted negatively to the rigidity forced by the DSS. This negative reaction caused the low satisfaction with the decision process.

Table 1. Effects of DSS Use on Key Decisional Factors

Decision Factor	Effect With DSS Use
Time to make a decision	No significant difference over time
Confidence in decision	Increases
Decision quality	Increases
Number of decision analyses considered	Increases
Satisfaction with decision	Decreases

In summary, the literature indicates that DSS usage affects several decisional factors. Decisions with DSS support take more time than without DSS support only until the users have become accustomed to the software. The time difference between the two groups approached zero after only three uses of the DSS (Sharda et al., 1988: 153). Research also indicated that DSS usage increases the number of alternatives considered, improves confidence in the decision, and improves decision quality. These results seem to forecast an increased rationality with DSS use.

The Source Selection Process

Within the last five years, the government has increased its dependence upon contractors to provide many products and services previously handled by the active duty military force. The means by which the government selects which contractor will provide the product or service is the source selection process. This discussion of the source selection process focuses on contracts governed by the Air Force Federal Acquisition Regulation (AFFARS), Appendix BB. This regulation deals with information technology contracts of less than $120M and other contracts of greater than $5M but less than $500M (AFFARS Appendix AA, 1997: 2). Contracts estimated to be over these values are governed by AFFARS Appendix AA which details a more formal structured source selection procedure. Appendix BB was chosen for this study because it is applicable to the majority of source selection processes.

When the government decides to contract a service or product out, the government completes a RFP, requesting proposals from contractors who can provide that product or service. These proposals are examined by groups of contracting officers and area experts, organized together as the Source Selection Evaluation Team (SSET).

The SSET reviews and evaluates the proposals and ultimately provides comparisons on their individual area of expertise. The technical and contractual areas depicted above would be further divided according to areas of expertise. Below is a chart depicting the organization created during the source selection process.

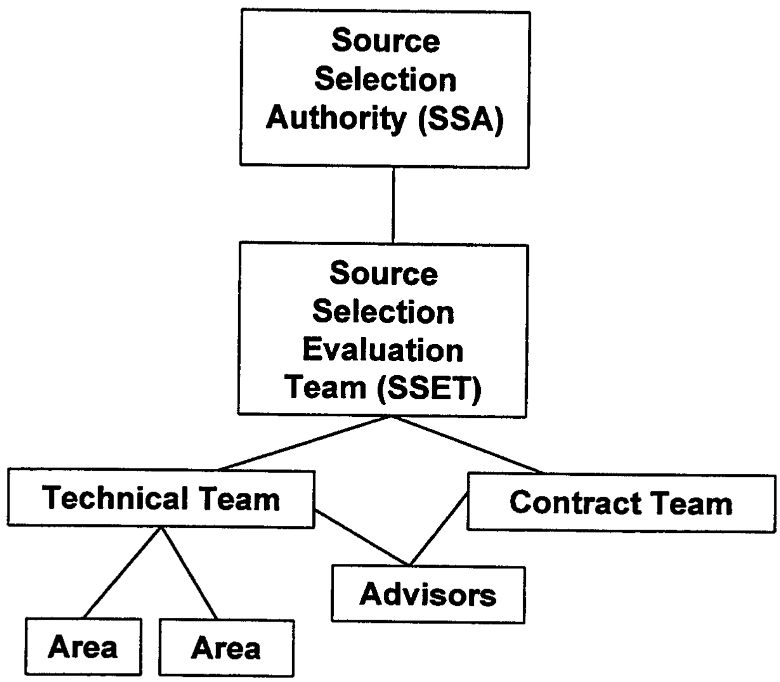

Figure 3. Source Selection Organization

(James, 1997: n.pag)

It is important to understand that the temporary organization depicted above is formed for each source selection (AFFARS Appendix BB, 1997: 7). When proposals are received from prospective contractors, they are received by the SSET. The separate technical and contracting teams, under supervision of the SSET, evaluate the proposals.

The SSA does not take part in any of the evaluation at this point. The SSA receives the completed evaluations and is tasked with making a decision, having only the information compiled by the SSET at his disposal.

The goal of the source selection process is to select the proposal providing the "best value" to the government. The best value criteria allows the government to select proposals that do more than meet the minimum requirements at the lowest cost. Appendix BB of the Air Force Federal Acquisition Regulations (AFFARS) provides guidance for the source selection process. It mandates that the selection of the contractor who provides the best value. Best value is described as "the most advantageous offer, price and other factors considered, providing the best mix of utility, technical quality, business aspects, risks, and price for a given application" (AFFARS Appendix BB, 1997:3).

The Source Selection Authority (SSA) is the single most important person in the source selection process. The SSA is an individual high-ranking contracting officer who has the responsibility of deciding which proposal will receive the contract. The AFFARS states that "the SSA is responsible for the proper and efficient conduct of the entire source selection process encompassing proposal solicitation, evaluation, selection, and contract award" (AFFARS Appendix BB, 1997: 7). The SSA is under no obligation to follow the advice provided by the SSET, but may look at all the information concerning the proposals and make his/her own decision. The final determination of which contractor is selected for an individual contract depends on one person's decision, the SSA. "The SSA has, subject to law and applicable regulations, full responsibility and authority to select source(s) for award and approve the award of the contract(s)" (AFFARS Appendix BB, 1997: 7). The SSA has the tremendous responsibility of sorting through great amounts of information and reaching the optimal decision for the government. It has been proposed that the source selection process could be improved with the implementation of a DSS for use by the SSA (Vickery, 1989: 3). DSS technology assists in the sorting, displaying, and comparing of large amounts of information such as are involved in the source selection process.

The AFFARS Appendix BB describes several important aspects of the source selection decision process. The decisional factors to be discussed in this section with regard to the source selection process are time to make a decision, number of alternatives considered, confidence in decision, satisfaction with decision, and decision quality.

Time to Make a Decision

One important aspect of source selection decisions is the time required to make a decision. The AFFARS states that the process should be accomplished with "maximum efficiency" (AFFARS Appendix BB, 1997: 2). Kathleen James, a representative from AFMC/PKPA, detailed in her briefing slides to Air Force SSA's that the SSP took about 75 days (from proposal to award decision) in 1990. She stresses in her slides that SSA's should try to minimize the time required to reach a decision (James, 1997: n.pag).

Confidence in Decision

The third important aspect of source selection decisions is that SSA's must have confidence in their decision. "You [SSA's] must be comfortable with your decision, and you must document its basis" (James, 1997: n.pag). Since contractors can question source selection decision, SSA's must be able to justify their selection of the particular proposal (contractor). SSA's must be confident in their decision in order to effectively defend their decision in the Source Selection Decision Document and subsequent briefings with contractors not selected.

Decision Quality

The most important aspect of the source selection decision is decision quality. The AFFARS states that the "objective of the SSP is to select the source whose proposal has the highest degree of credibility and whose performance can be expected to best meet the Government's requirements at an affordable cost" (AFFARS Appendix BB, 1997: 2). The degree to which the decision selects the 'best value' proposal is the decision quality.

Decision Analyses Considered

A second important aspect of source selection decisions is the number of analyses considered. The AFFARS states, "the SSA shall be presented with sufficient in-depth information on each of the competing offerors and their proposals to permit a reasoned, rational selection decision" (AFFARS Appendix BB, 1997: 4). DSS increases the amount of information that can be gathered and processed, an important part of the rational model. Though rational decision-making has been shown to be impossible given the human limitations, perhaps use of a DSS can increase the gathering, processing, and understanding of greater amounts of information and thus improve the rationality of the source selection decision-making process.

Satisfaction with Decision

The SSA training slides lists four objectives for SSA's to keep in mind throughout the process. One of these objectives is user satisfaction (James, 1997: n.pag). It is important for the SSA to be satisfied with the decision and the process leading up to the decision. The briefing goes so far as to say that success entails SSA satisfaction with the decision (James, 1997: n.pag).

In summary, there are many factors important to source selection decisions. They are timeliness, amount of alternatives considered, confidence, and decision quality. The maximization of these four factors will improve the source selection decision process. Any changes in the SSP should improve these factors.

Problem

DSS technology has been commercially available for over fifteen years but has made few inroads into the government source selection process. This study will look at the effects of DSS usage on source selection decisions and attempt to answer the following question. Will the introduction of DSS technology into the source selection process improve the time needed to make a decision, the number of decision alternatives considered, decision confidence, and decision quality?

Assumptions

The major assumption for this study is that there is a commercially available DSS able to facilitate the source selection decision process. The existence of this DSS will be central to the interview process. In the interviews, the feasibility of utilizing a functional and available DSS will be assumed. This will ensure that the interviewees will not take into account the development of a new system, and all the problems therein, into their responses.

Research Hypotheses and Propositions

The methodology for this study is two-fold. First, experimental data was analyzed. This study addressed DSS usage in a source selection decision setting. Empirical results from this study should allow testing of the following hypotheses:

H1: The introduction of DSS technology into the source selection process decreases decision time.

This hypothesis addresses the impact of using DSS technology on the time required for each person to reach their decision. DSS technology could be ignored if it is shown to delay the source selection process.

H2: The introduction of DSS technology into the source selection process increases decision confidence

Confidence addresses the belief, after reaching a decision, that they made the right decision. The confidence that the decision-makers feel after reaching a decision is an important construct because the decision-makers must be able to trust their DSS-aided decision.

H3: The introduction of DSS technology into the source selection process increases decision quality.

This hypothesis addresses the impact of using a DSS to reach a decision on the decision's quality. The resultant decision is the most important part of the decision process and the effect of DSS on it is of prime importance.

Once these hypotheses are answered, we will have information on what impact DSS usage has on the source selection process. The second step in this study will be to interview individuals involved in the source selection process. During the interview, the empirical results will be discussed as a means of determining their perceptions on the feasibility of DSS integration into the source selection decision-making process. Examination of the qualitative interview data allows the addressing of the following propositions:

P1: The introduction of DSS technology into the source selection process increases the number of decision analyses considered prior to reaching a decision.

The literature has shown that the number of decision analyses conducted is positively correlated to the quality of the ultimate decision. This proposition compares the number of decision analyses considered in the decision-making process with and without DSS use.

P2: The introduction of DSS technology into the source selection process increases satisfaction with the decision process.

This proposition addresses the satisfaction the decision-makers feel with the decision process and whether the satisfaction will differ between individuals using the DSS and those who do not.

P3: The perception of DSS technology within the source selection community has improved within the last five years.

Computer-based DSS technologies have met with resistance in the past and now that computers are an integral part of the work environment, an improved perception of DSS technology was proposed. An improving perception of the technology within the source selection community is important if the technology is to be implemented.

P4: The source selection community foresees DSS technology being implemented within the decision process.

It is important to determine whether the source selection community believes this technology has a future in the process. This proposition addresses whether individuals involved in the process are of the opinion that this technology will be a part of the process in the future.

The interviewees, though not necessarily a representative sample, will provide insight into propositions four through seven. Their active involvement within the source selection process will allow the discussion of these propositions and the formulation of questions for further study

Conclusion

Decision-making is an integral part of human existence. Given the human information processing limitations discussed above by Simon and Miller, a computer-based DSS could improve the decision process by handling the information processing and comparing tasks vital to decision-making. The literature has shown evidence that DSS usage improves the timeliness, number of alternatives considered, confidence, and quality when compared to decisions without DSS support. It has also been shown that source selection decisions also require timeliness, a maximum number of alternatives considered, confidence in the decision, and decision quality. Since DSS have been shown to increase the same decisional factors that are important to the source selection process, I will attempt to show that DSS will have the same effects on source selection decisions.

The following chapter will describe the methodology to be used to address these hypotheses. As stated above, the methodology will include both empirical data from an experiment and interviews conducted with experts in the source selection community. The methodology chapter will describe how the data was gathered, how the hypotheses and propositions will be tested, and why these methods were chosen.

III. Methodology

Introduction

This study will use a two-pronged methodology, consisting of the analysis of data from a previous experiment and an interview. The first segment is an experiment on the effects of DSS usage on several decision variables to address hypotheses one through three. The topics of research design, discussion of variables, and discussion of hypotheses will be addressed in this section. The second section is a series of interviews conducted with managers within the source selection process that will address propositions one through four. The interview questionnaire will be described in this section.

Experiment

The experiment and resultant data described in this study was accomplished for a previous AFIT thesis (Vickery, 1989). This experiment effectively measured the results of DSS usage on decision factors. At the time this study was conducted, Likert data could only be manipulated with limited statistical tests but since that time it has been shown that Likert data can be manipulated as interval data, allowing for increased statistical power. This fact leads us to a new examination of the data taking advantage of improved statistical tests.

Research Design

The experiment conducted in this study is a post-test-only control group design. This design was used to test the three hypotheses in this study. The post-test-only control group design uses one experimental group and one control group as depicted below where X_1 is the experimental treatment and O_1 and O_2 are post-test observations (Cooper and Emory, 1995: 364).

(R)	X_1	O_1
(R)		O_2

The more common research design would have been the pre-test-post-test control group experimental design depicted below where O_1 and O_2 denote the pre-test observations, X_1 denotes the experimental treatment, and O_3 and O_4 denote post-test observations (Cooper and Emory, 1995: 364).

O_1	X_1	O_3
O_2		O_4

Campbell and Stanley describe the pre-test design as a means to ensuring the equality between the experimental and control groups (Campbell and Stanley, 1966: 25). The pre-test research design has also been shown to possibly introduce bias into the control group that could invalidate the experimental results (Campbell and Stanley, 1966: 14).

Campbell and Stanley state that the pre-test notion is "not actually essential to true experimental designs" (Campbell and Stanley, 1966: 25). They continue to defend the validity of the post-test only design used in this study by stating "the most adequate all-purpose assurance of lack of initial biases between groups is randomization. Within the limits of confidence stated by the tests of significance, randomization can suffice without the pretest" (Campbell and Stanley, 1966: 25).

The experimental treatment in this study (X_1) is the use of a decision support system called Expert Choice. This decision software includes the essential elements of a DSS. It is based on the Analytical Hierarchy Process that breaks down complex decisions into competing component parts. The decision-maker then assigns numerical values to each component and establishes the relationship between components. The alternative comparison entered by the decision-maker can be done objectively or subjectively. The subjective comparison would merely state preference of one alternative to another while the objective comparison would assign specific numerical values to the relationship between alternatives. The software analyzes the subsequent relationships and "graphically portrays the problem, conflicting criteria and alternatives" (Vickery, 1989: 22). The Expert Choice software "synthesizes the information and provides a rank-ordered list of alternatives" from the user-inputted information (Vickery, 1989: 22). In this study, the control group was tasked with reaching a decision without the Expert Choice software while the experimental group was provided the software. Assignment to the control and experimental groups was done randomly to control for the variables. This is an essential part to the post-test-only design (Campbell and Stanley, 1966: 25).

Procedure

To begin the experiment, both the experimental and control groups were briefed on the decision scenario. The subjects of this experiment were AFIT Masters candidates. They were separated into control and experimental groups randomly. This briefing included a description of the multiple competing criteria as well as the choices available for the ultimate decision. The experimental group was then introduced to the DSS treatment and provided an explanation of the Analytical Hierarchy Process (AHP). Each individual within the experimental group was provided an identical computer loaded with the Expert Choice software. The control group was asked to use whatever decision-making method they felt most comfortable with. The post-test consisted of a complex decision scenario. After completing the scenario and reaching a decision, each subject filled out a questionnaire designed to test the variables to be described in the "Discussion of Variables" section.

The post-test only experimental design effectively controls the threats to internal validity (Emory, 1980: 121). The major threat to internal validity is whether the results were due to the AHP training or the DSS itself. Knowledge of the AHP is integral for the effective use of the DSS system. In fact, the DSS system is based largely on the AHP. Separating these two effects is not necessary because the AHP is part of the DSS. If the results are positive, later studies can investigate the individual roles of the AHP and the DSS.

The post-test-only control group experimental design is not as effective in controlling for external validity. The two main concerns in this area are whether the test affected the subjects and whether the results can be generalized to the population in question. The problem of the subjects being affected by the act of being tested is primarily a problem in the pre-test-post-test experimental design where the pretest introduces unusual activities (Emory, 1980: 121). This study, without a pre-test, greatly reduces the risk of this type of threat to external validity. The subjects in this study were AFIT students who were familiar with the acquisition process, thereby also reducing the risk of this type of threat to external validity.

The ability to generalize the results of this study to the population in question, namely the source selection authorities in the contracting arena, represents another threat to external validity. The sample population in our experiment was limited to forty-five AFIT students. These subjects can be assumed to be a representative sample of the population since these students are precisely those who will make up that population in future years. As Air Force officers, these subjects were relatively typical of the population in question, possessing similar educational and professional backgrounds.

Variables

The variables used in this study were derived from the author's study of the literature surrounding this subject area and the subsequent decision-making model described in the literature review.

Independent Variable

The independent variable (X_1) for this experiment is the use of the Expert Choice computer-based DSS. The subjects were introduced to the capabilities of the Expert Choice software and provided training on the Analytical Hierarchy Process on which the

DSS is based. Each subject was then provided identical computers loaded with the Expert Choice software, given a complex decision scenario, and tasked with selecting the optimal decision.

Dependent Variables

The following dependant variables will be used to test the hypotheses:

Time to Make a Decision. The actual amount of time required to reach a decision. This was measured directly in this experiment.

Confidence in Decision. A measure of the decision-maker's belief that the choice selected was the optimal choice available.

Decision Quality. This is a measurement of the ability to select the "best" alternative from a list of choices. A panel of experts was used to examine the decision scenario and select the "best" alternative. Since the decision scenario was based on a source selection decision, the expert panel was composed of individuals experienced in the government source selection decision process. The subjects' decisions were compared to the expert panel's decision and if they were the same, the subject made a quality decision.

Number of Analyses Considered. This is a measure of the number of different ways the information was compared prior to making a decision.

Satisfaction with Decision Process. A measure of the decision-makers contentment with the decision-making process used to make the decision.

Discussion of Hypotheses

Chapter II discussed the decision-making model and human limitation in dealing with information. Due to these limitations, DSS have been developed to aid the decision-maker in reaching as rational a decision as possible. The goal of these DSS systems is to improve the decision process. In this experiment, we attempted to determine if the introduction of a DSS into the decision-making process would impact the dependent variables.

The following research hypotheses were formulated:

H_1 **The introduction of DSS technology into the decision-making process decreases the time required to reach a decision.**

This hypothesis addresses the impact of using DSS technology on the time required for the decision-maker to reach their decision. The research hypothesis states that using DSS will not affect the time. It is important to determine the time effects since DSS technology could be disregarded if it is shown to delay the source selection process.

H_2 **The introduction of DSS technology into the decision-making process increases the confidence with the decision.**

Confidence addresses the belief, after reaching a decision, that the decision-maker made the right decision. The confidence that the decision-makers feel after reaching a decision is an important construct because the decision-makers must be able to trust their DSS-aided decisions.

H_3 The introduction of DSS technology into the decision-making process increases decision quality.

This hypothesis addresses the impact of using a DSS to reach a decision on the decision's quality. The resultant decision is the most important part of the decision process and the effect of DSS on it is of prime importance.

Previous Results

The previous study gathered data using a questionnaire with a five-point Likert scale. The study measured the level of agreement or disagreement with several decision variables. The decision variables tested included decision effectiveness, consistency, speed, difficulty, understanding and confidence. The resultant data was condensed into ordinal format and the hypotheses were tested using Gamma as a correlation coefficient. Gamma is a statistic that "compares concordant (P) and discordant (Q) pairs and then standardizes the outcome by maximizing the value of the denominator" (Cooper and Emory, 1995: 506). The gamma statistic is defined as:

$$\gamma = (P-Q)/(P+Q)$$

The previous study reached conclusions using statistical tests that have recently been shown to be less than optimal. The results showed that DSS usage increased decision time, decreased perceived decision-making difficulty, increased the understanding of the decision-making process, and increased decision confidence. No significant results were found for consistency and effectiveness (Vickery, 1989: 53-55). This study seeks to gain an increased insight into the raw data, testing the hypotheses with increased statistical tests. The goal is that the new statistical tests will allow us to more accurately test the hypotheses.

Hypothesis Testing

Now that Likert scale data can be analyzed as interval data, the means by which the hypotheses will be tested will change greatly. Each hypothesis will be tested with the analysis of variance (ANOVA) statistical method (Cooper and Emory, 1995: 457). This method tests the null hypothesis that the means of several populations are equal. Cooper and Emory describe this test as follows:

> (ANOVA) uses a single-factor, fixed-effects model to compare the effects of one factor on a continuous dependent variable. To use this method several assumptions must be met. The samples must be randomly selected from normal populations, and the populations should have equal variances. ANOVA is reasonably robust, and minor variations from normality and equal variances are tolerable. (Cooper and Emory, 1995: 457)

The test statistic for the ANOVA compares the variances and is called the F-ratio. The F-ratio is defined as:

$$F = \text{Between-groups variance} / \text{Within-groups variance}$$

To use the ANOVA test, several assumptions must be met. The "samples must be randomly selected from normal populations and the populations should have equal variances. ANOVA is reasonably robust, and minor variations from normality and equal variances are tolerable" (Cooper and Emory, 1995: 457).

Interview

In order to gain insight into the perception of DSS within the source selection community, interviews were conducted with several individuals closely associated with the Air Force's source selection process. The sample of source selection experts interviewed for this study was a convenience sample. The subjects were presently either conducting source selections or involved in source selection planning/oversight at Electronic Systems Center (ESC), Air Force Material Command (AFMC), and Aeronautical Systems Center (ASC). The interviews were conducted over the telephone and closely followed a list of questions centering on four main areas: general concerns with the source selection process, experiences with DSS, possibility of DSS implementation in the source selection process, and perceptions of DSS impact on the key decisional factors.

The telephone interviewing method of information gathering was chosen in order to contact geographically separated individuals and acquire the "depth and detail of information" this technique affords (Cooper and Emory, 1995: 271). Cooper and Emory describe three main conditions that must be met to have a successful interview. They are "(1) availability of the needed information from the respondent, (2) an understanding by the respondent of his or her role, and (3) adequate motivation by the respondent to cooperate" (Cooper and Emory, 1995: 271). Of these conditions, the first was met since the questions were focused on attaining an understanding of the respondents' individual perceptions and these perceptions were available to them during the interview. The second condition was addressed during the introduction phase of the interview. In this phase, the respondent was informed of the two-phase methodology of this study and where their inputs would be used. The goal of this phase was to provide the respondent an understanding of his or her role in the study. The third condition is more difficult to address. The goal of the introduction phase of the interview was to detail the scope of the study and establish a friendly relationship with the respondent in the hope that this would motivate the cooperation of the respondent.

Some disadvantages with the telephone interviewing method include a limited interview length and less complete responses. The limitation on interview length did not apply since the length of this interview (15-20 minutes) fell well within the acceptable range (Cooper and Emory, 1995: 281). The concern with less complete responses was mitigated by the interviewing technique used. When responses were incomplete, the interviewer used probing techniques to more fully and relevantly respond to the questions. The probing techniques used included expectant pauses, repeating the question, agreeing with the respondent, and neutral questions.

To begin the interview, the subjects were provided a brief description of the research effort. Each subject was given a description of a computer-based DSS as described in the literature review to minimize confusion in this area. The positions and office symbols of each interviewee were also noted.

Subjects were first asked to explain their concerns with the source selection process as it presently exists and suggestions as to how they would improve the deficiencies they defined. These questions were aimed at gaining an insight into the subjects' general perspectives of the source selection process.

Before asking specific question concerning DSS, each individual was asked to describe any personal experience with a DSS in the source selection process. This included how the DSS was acquired, the impact it had on the process, and other proposed areas for implementation. These questions address the present level of DSS usage within the source selection process.

Each subject was then asked whether they foresee DSS being implemented in the source selection process. They were also questioned as to where in the process the

DSS should be implemented with a focus on whether they personally are open to the possibility of using a DSS within their job. The emphasis of this section was to gauge their perception of future DSS implementation.

Finally, each subject was asked to predict the impact of DSS usage on the decisional factors of decision time, alternatives considered, confidence, satisfaction, and quality. The subjects were asked to accomplish this for both a DSS used by the SSA and a DSS used in lower process levels. The choices for each decision factor were limited to increase, decrease, or remain the same. This quantified their perceptions of how DSS usage would affect the source selection process at both levels. The interview questionnaire used in this study is included in the appendix.

Proposition Evaluation

The data gained through interviews will address the propositions. These propositions will not be tested with statistical tests but will be addressed with a "preponderance of evidence" test. The following propositions will be addressed using the interview data:

P_1 The introduction of DSS technology into the decision-making process increases the number of ways the information was analyzed.

The literature has shown that the number of decision analyses conducted is positively correlated to the quality of the ultimate decision. This proposition compares the number of decision analyses considered in the decision-making process with and without DSS use.

P_2 The introduction of DSS technology into the decision-making process increases satisfaction with the decision process.

This proposition addresses the satisfaction the decision-makers feel with the decision process and whether the satisfaction will differ between individuals using the DSS and those not using the DSS.

P_3 The perception of DSS technology within the source selection community has improved within the last five years.

Computer-based DSS technologies have met with resistance in the past. With the computer's acceptance as an integral part of the work environment, an improved perception of DSS technology was proposed. An improving perception of the technology within the source selection community is important if the technology is to be implemented.

P_4 The source selection community foresees DSS technology being implemented within the decision process.

It is important to determine whether the source selection community believes this technology has a future in the process. This proposition addresses whether individuals involved in the process are of the opinion that this technology will be a part of the process in the future.

<u>Conclusion</u>

The two-fold methodology described in this section details how the hypotheses and propositions will be addressed. The experimental data gained from the previous study will be used to test hypotheses one through three. This will be accomplished using the ANOVA statistical test. The interview data, gathered from individuals presently working within the source selection process, will be used to address propositions one through four. The goal of using the combination of experimental and interview data in this study is to address the hypotheses and propositions and gain insight into the perceptions of DSS within the source selection community. The following chart details how the hypotheses will be tested:

Table 2. Hypothesis/Proposition Test Methods

Hypotheses and Propositions	Test Method
H1. DSS usage decreases the time required to make a decision	Empirical data from experiment (ANOVA)
H2. DSS use increases the confidence in the decision	Empirical data from experiment (ANOVA)
H3. DSS use increases decision quality	Empirical data from experiment (ANOVA)
P1. DSS use increases the number of ways the information was analyzed prior to reaching a decision	Interview data
P2. DSS use increases the satisfaction with the decision process	Interview data
P3. The perception of DSS technology within the source selection community has improved within the last five years	Interview data
P4. The source selection community foresees DSS technology being implemented within the decision process	Interview data

The analysis of these hypotheses and propositions will provide important information concerning the viability of implementing DSS technology within the contracting source selection process. The three hypotheses address the impact of DSS usage on key decisional factors using empirical data taken from a previous study. Propositions one and two address the perceived impact of DSS implementation on other decisional factors. Finally, propositions three and four address the perception and future of DSS technology within the source selection community. The next chapter will describe the results of addressing these hypotheses and propositions and describe the other information gathered from the interview process.

IV. Analysis

Introduction

This chapter will focus on the testing of the hypotheses and propositions described in this study and the reporting of free-form data gathered from the interview process. The Hypotheses section will address the information gathering and the results of testing the three hypotheses and four propositions described in the Methodology section. The Free-Form Data section will discuss other information gained from the interview process.

Findings

This study utilizes a two-part methodology to address the hypotheses and propositions. The first three hypotheses address time, confidence, and decision quality and will be analyzed using empirical data from a previous study. Propositions one through four will be addressed using interview data gathered for this study.

Time to Make a Decision

Hypothesis 1. The introduction of DSS technology into the decision-making process decreases the time required to reach a decision.

By measuring the number of minutes each decision-maker required to reach their decision, an objective measure of time was attained. Figure 4 depicts the results of the control and experimental groups with respect to time. The figure shows that the control group seemed to require less time to make a decision than the experimental group.

The ANOVA statistical test was used to test hypothesis number 1. This hypothesis addresses whether individuals using DSS technology will require less time to make a decision when compare to decision-makers not using DSS technology.

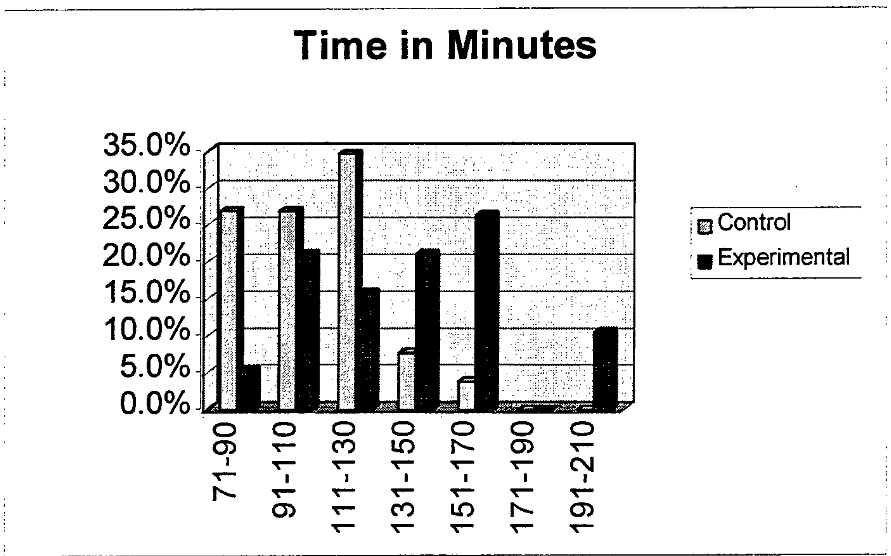

Figure 4. Distribution of Time in Minutes

This research hypothesis is not supported. The statistical analysis detailed below shows that the average time for the control group was 108.96 minutes while the average time for the experimental group was 140.00 minutes. The ANOVA test was used to determine if this difference is statistically significant. When these two groups are tested according to time, the results clearly show that the means are not equal (F > Fcrit) and that the experimental (DSS) group required more time than the control group to reach a decision.

Table 3. ANOVA Statistics for Time

ANOVA: Single Factor SPEED

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Control	26	2833	108.96154	483.47846
Experimental	19	2660	140	1185.8889

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	10575.838	1	10575.838	13.602177	0.0006301	4.0670471
Within Groups	33432.962	43	777.51073			
Total	44008.8	44				

This research hypothesis is not supported since the information above shows that DSS usage actually increased the time required to reach a decision.

Confidence in Decision

Hypothesis 2. The introduction of DSS technology into the decision-making process increases the confidence with the decision.

Confidence was measured using a five-point Likert scale questionnaire. The statement "I am confident that I made the right decision" was used to address this dependent variable. Neutral responses were discarded. Strongly agree and mildly agree responses were combined into a single agree category. The same was done for the disagree responses. As seen in Figure 5, there is a slight difference between the two groups which indicates an increase in confidence with the experimental group.

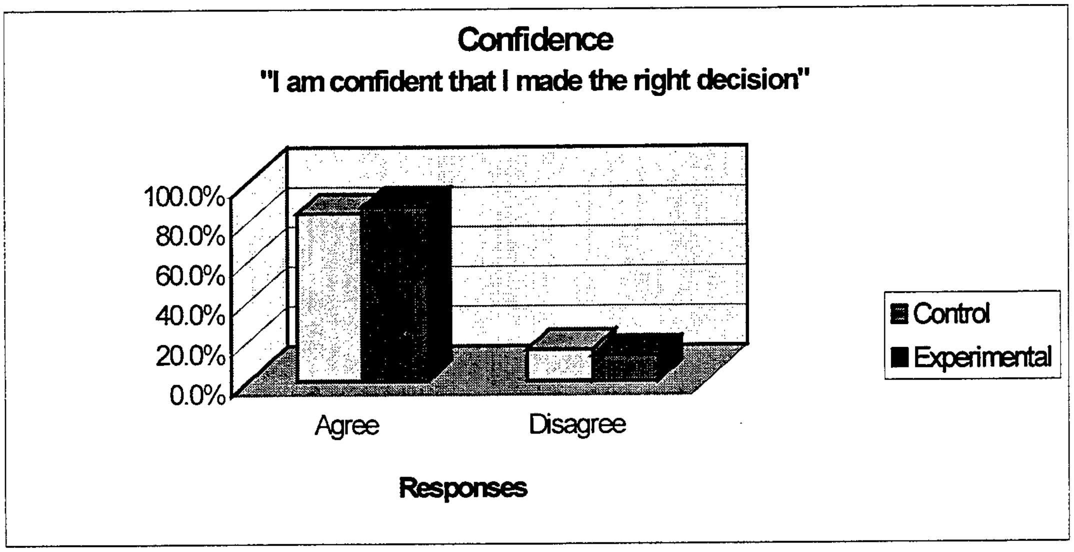

Figure 5. Distribution of Confidence Level

Hypothesis two was also analyzed using the ANOVA statistical test. This hypothesis addresses the confidence the decision-makers had that they made the right decision and whether this differed between the control and experimental groups.

This research hypothesis is not supported. The average value for the control and experimental groups were 2.27 and 2.16 respectively. These numbers correspond to the five-point Likert scale with lower numbers relating to a stronger feeling of confidence. When these means are tested with the ANOVA test statistic, no statistically significant difference between the two groups can be found (F<Fcrit).

Table 4. ANOVA Statistics for Confidence

Anova: Single Factor Confidence

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
confidence	19	22	1.157895	0.140351
confidence	17	20	1.176471	0.154412

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.003096	1	0.003096	0.021066	0.885457	4.130015
Within Groups	4.996904	34	0.146968			
Total	5	35				

Decision Quality

Hypothesis 3. The introduction of DSS technology into the decision-making process increases decision quality.

Decision quality was measured objectively by comparing the decision reached with the correct answer. Figure 6 shows the strong similarity in the decisions reached by the control and experimental groups. The "correct" answer for this decision scenario, as determined by a panel of experts, was the selection of Magnetic Tech.

Hypothesis three was also tested using the ANOVA statistical test. This hypothesis addresses the difference between the control and experimental groups' ability to select the "best" alternative.

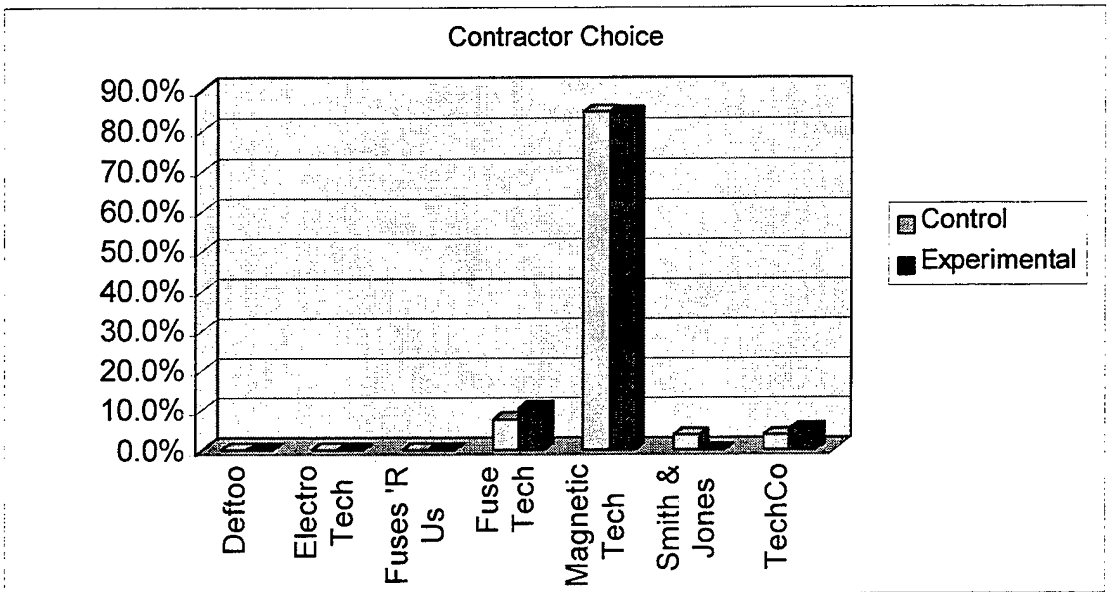

Figure 6. Distribution of Decision Choice

This research hypothesis is not supported. The means of the control and experimental groups are nearly identical and the ANOVA test fails to show a significant difference between the two values (F<Fcrit).

Table 5. ANOVA Statistics for Decision Quality

Anova: Single Factor Quality

SUMMARY

Groups	Count	Sum	Average	Variance
Control	26	34	1.3076923	0.6215385
Experimental	19	24	1.2631579	0.4269006

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.0217724	1	0.0217724	0.0403146	0.8418135	4.0670471
Within Groups	23.222672	43	0.5400621			
Total	23.244444	44				

Decision Analyses Considered

Proposition 1. This proposition addresses a perception of DSS within the source selection community. Research seems to suggest that the more ways the information pertaining to a decision is analyzed, the better the resultant decision will be (Cats-Baril, 1997: 368). Because of this relationship, this was included as a proposition in this study. Lacking empirical data in this area, the interview process was used to gather the data required. Each interviewee was provided a description of the capabilities and limitations of DSS and asked whether they believed that the use of such technology would have an impact on the "number of ways the information is analyzed prior to reaching a decision." The respondents were allowed only to respond with increase, decrease, or no change.

P_1 The introduction of DSS technology into the decision-making process will increase the number of ways the information was analyzed

This proposition is not supported by interview results. 63% of the interviewees believed that the introduction of DSS technology into the source selection process would have no impact on the number of ways the information would be analyzed prior to reaching a decision. The results are depicted in Figure 7.

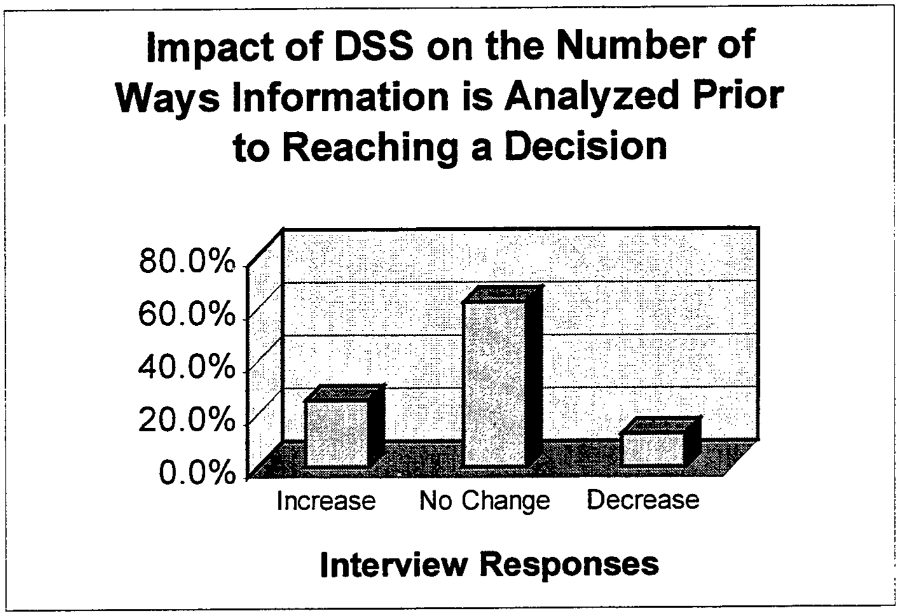

Figure 7. Distribution of Change in the Number of Ways Information is Analyzed with DSS Use

Satisfaction with Decision

Proposition 2. This proposition addresses the satisfaction the decision-makers feel with the decision process and whether this will change with the introduction of DSS technology. This proposition was also addressed using interview data gathered from experts within the source selection process. They were asked whether they believed the satisfaction with the decision process would increase, decrease, or remain the same with DSS use.

P_2 The introduction of DSS technology into the decision-making process will increase the satisfaction with the decision process.

This proposition is not supported by the interview responses. The interview responses were evenly distributed between "no effect" and "increase." The interview results are inconclusive and thus we cannot support the proposition. The response distribution is displayed in Figure 8.

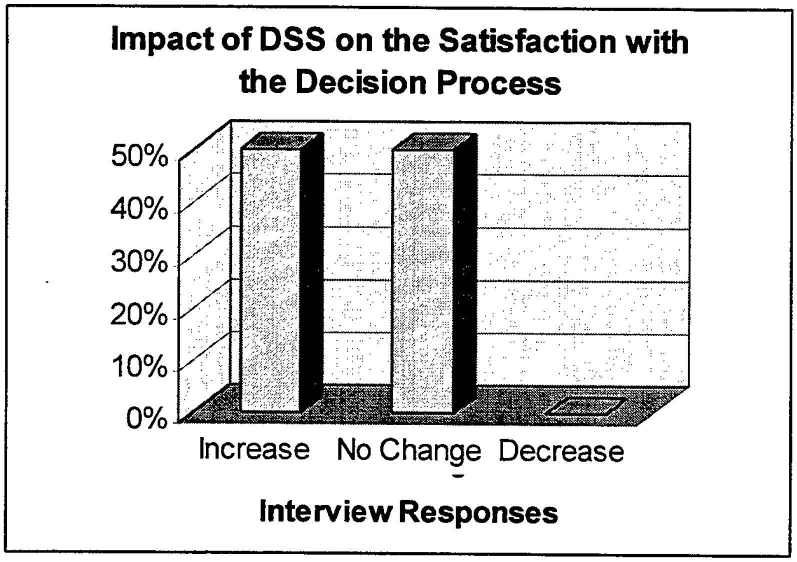

Figure 8. Distribution of Decision Satisfaction

Perception of DSS Technology

Proposition 3. Computer-based DSS technologies have, in the past, met with resistance by certain employees. Now that computer-based technology has become commonplace in the work environment within the last five years, an improved perception of DSS technology within the source selection community was proposed. Interview data was used to address this proposition. Individuals working within the source selection process were asked whether they believed the "perception of DSS technology within the source selection community has improved within the last five years."

P_3 The perception of DSS technology within the source selection community has improved within the last five years.

The interview data supports this proposition. 75% of the interviewees stated that the perceptions of DSS within the source selection community have improved within the last five years while the other 25% stated that there was no change. The results are depicted in Figure 9.

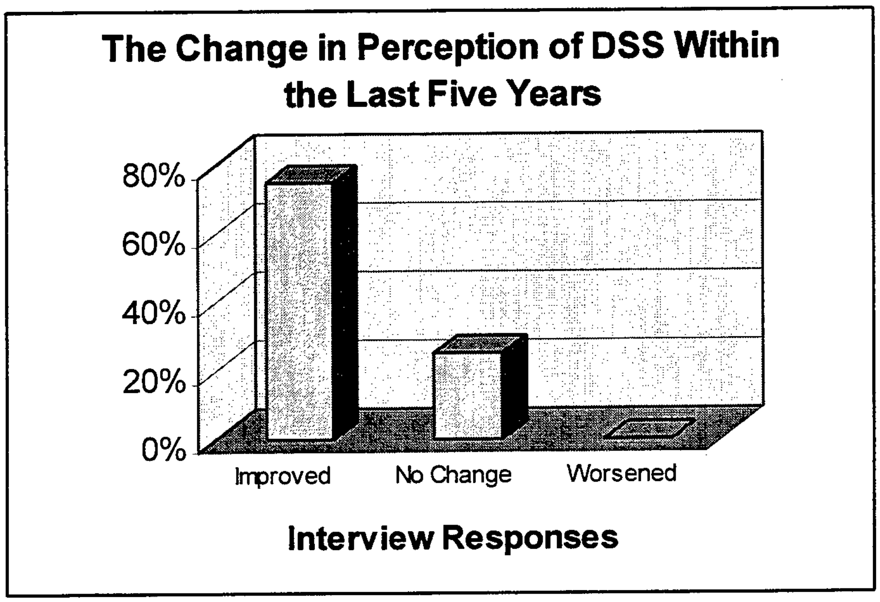

Figure 9. Distribution of Change in DSS Perception

DSS Implementation

Proposition 4. Eventual introduction of DSS technology within the source selection process is dependent largely upon the very individuals interviewed for this study, the professionals working in the planning and actual decision-making process. It was proposed that the interviewees would foresee DSS technology being implemented in the source selection process.

P_4 The source selection community foresees DSS technology being implemented within the decision process.

The interview data supports this research proposition. The interviewees almost unanimously believed that DSS technology would be implemented within the source selection process. Though many of the respondents mentioned different areas for DSS implementation and different benefits of such implementation, the great majority foresees DSS technology being used in the decision process.

The interview data supports the proposition that DSS technology will be implemented in the process. 88% of the interviewees stated that they foresee DSS technology being implemented in the source selection process. The distribution of interview responses is depicted in Figure 10.

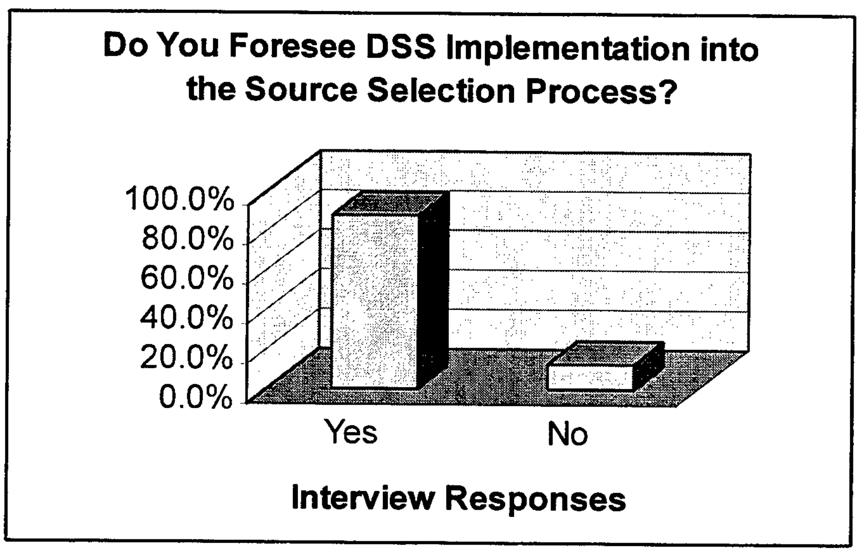

Figure 10. Distribution of Foreseen DSS Implementation

Free-Form Data

This section will address other questions asked in the interviews of individuals involved in the source selection process.

1. What are your present concerns with the source selection process?

The most common responses to this question had to do with the complexity of the process, the time it takes, and the formation of teams. The complexity of the process prevented the customer/buyer from understanding what was involved and had a large impact on the time required to complete the process. As service providers, the interviewers felt that their process could be simplified and therefore sped up. That is what the customers are looking for, a quality product delivered quickly. The personnel issue was also mentioned by about 75% of the interviewees. They emphasized the importance of quality people being involved. They stated their frustration with the large team sizes and high turnover rates. The interviewees believed that the combination of these effects led to teams being composed of individuals who are untrained and unfamiliar with the process, further delaying the process.

2. What can be done to improve the source selection process?

As with the question above, the responses concentrated on simplifying the process and improving the training. About 40% of the interviewees stated that the number of criteria examined for each source selection could be reduced in order to focus attention on those few "discriminators." Training continued to be a area of concern for the interviewees. A pervasive concern mentioned by the interviewees was that teams were being compiled of untrained members and this was reducing their effectiveness and efficiency. They believed a training program that is more flexible and implemented with more pre-planning would benefit the process.

3. Are you presently using a DSS within the source selection process?

No interviewee was presently using a formal DSS specifically designed for the source selection process. They were all using basic computer software (Microsoft Excel) in the process to capture some of the benefits of DSS technology to include the compiling and displaying of large amounts of information. Several interviewees mentioned that they had received training on a commercial-off-the-shelf Group DSS system that was planned for implementation in the near future. This system was procured to improve the consensus building between group members and aid in the documentation of the process.

4. What do foresee as the impact of using DSS technology within the source selection process?

The answers ranged greatly to this question. Some respondents felt that the DSS would create an over reliance on "hard" data and reduce the discussion between decision-makers. Others felt the capabilities of DSS technology would improve the process by allowing the decision-maker to access great amounts of lower-level, detailed information when needed. Several interviewees also mentioned that a Group DSS would facilitate consensus building within groups involved in the process.

5. Where in the process do you foresee DSS technology being used?

Over 80% of the interviewees believed DSS technology would best be applied at the lower levels within the source selection process. They believed that though the model building, information retrieval, and display capabilities could benefit the SSA, the real benefits would be seen in its implementation within the technical and contractual teams. GDSS technology was often mentioned as a beneficial DSS technology for building consensus within the separate technical expertise areas.

6. What do you foresee being lost with DSS implementation within the source selection process?

About half the interviewees believed that nothing would be lost if DSS technology was implemented in the process. The other half mentioned concerns of lost subjectivity. There seemed to be a fear that the DSS would have a "magic formula" that would provide the right answer to the decision-maker. The fear was that subjective areas would be ignored with the emphasis on numerical data and that the decision-maker would lose his/her power.

Conclusion

Of the seven research hypotheses and propositions addressed in this study, the data supported only two. Propositions three and four were supported by the data. Table 6 summarizes the results of the analysis in this study.

Table 6. Results of Hypothesis/Proposition Testing

Hypotheses/Propositions	Test Method	Results
H1. DSS usage decreases the time required to make a decision	Empirical data from experiment (ANOVA)	Not Supported
H2. DSS use increases the confidence in the decision	Empirical data from experiment (ANOVA)	Not Supported
H3. DSS use increases decision quality	Empirical data from experiment (ANOVA)	Not Supported
P1. DSS use increases the number of ways the information was analyzed prior to reaching a decision	Interview data	Not Supported
P2. DSS use increases the satisfaction with the decision process	Interview data	Not Supported
P3. The perception of DSS technology within the source selection community has improved within the last five years	Interview data	Supported
P4. The source selection community foresees DSS technology being implemented within the decision process	Interview data	Supported

Though several research hypotheses/propositions were not proven, two important propositions were supported. The interviewees believed that the perception of DSS technology has improved within the last five years. They also stated their belief that DSS technology will be implemented within the source selection process. The free-form data gained from the interview process also provided many interesting points concerning the use of DSS in the source selection process. These will be discussed further in the following chapter.

V. Conclusions and Recommendations

Introduction

In the conclusion, a brief summary of the results found in chapter IV will be presented with an added emphasis on the importance of these findings. From the information discussed in the Conclusions section, suggestions will be made in the Recommendations section for further research in this subject area.

Results

The two-part methodology employed in this study provided information ranging from empirical data (experimental) to personal conversations with individuals involved in the source selection process (interviews). The results of the analysis of the empirical data were disappointing to the author. The inability to show any positive relationship between DSS usage and the constructs of time, confidence and decision quality concurred with the previous study (Vickery, 1989) but differed from the consensus of literature discussed in Chapter II. The statistical tests employed in this study did not support the research hypotheses dealing with time, confidence, and decision quality. The difficulty in showing the hypothesized relationships could be caused by the experiment itself. Though time to make a decision actually increased with DSS use, this could be explained by the learning curve. The subjects used in this study were inexperienced with the DSS software and the added time they required to reach a decision could be due their inexperience using the software and not due to the DSS itself. The measurement of decision time after the subjects had experience with the

DSS and were comfortable with it could lead to an improved isolation of the effect of DSS use on decision time by effectively removing the learning curve effect. The literature demonstrated this proposed "learning curve" effect with respect to DSS. Studies have shown differences between DSS users and non-DSS users disappear after several trials (Sharda, 1988: 153), (MacKay, 1992: 660-663).

The research hypothesis addressing levels of confidence was also not supported. The levels of confidence for both the experimental and control groups were nearly identical. Though the experimental group, using the DSS, did show higher levels of confidence, the difference was not shown to be statistically significant. This corresponds to the slight positive effect evidenced in the literature (Cats-Baril and Huber, 1987: 370), (Sharda, 1988:154).

The research hypothesis with respect to decision quality was also not supported. One possible explanation for these results could be due to the relative simplicity of the decision scenario. Over 80% of both the control and experimental decision-makers selected the optimal decision. The introduction of a more difficult decision scenario could spread the data and perhaps show some difference between the two groups. The decision scenario, though modeled after a source selection decision scenario, lacked the complexity that is involved in actual source selection decisions.

The interview data provided unique insight into the perceptions of individuals involved in the source selection community. Though the interviewees were far from a representative sample of everyone involved in the source selection arena, they were individuals involved in the planning and oversight of the source selection process at the major command and system center level. The perceptions of these individuals with respect to DSS will greatly influence its possibility for implementation in the process. The interview data addressed the four propositions and also provided free-form data that proved significant.

Two research propositions were supported by the interview data. The perception of DSS technology within the source selection community was shown to have improved in the last five years. The interviewees repeatedly stated that the increased reliance on the desktop computer within the office environment has removed many, but not all, reservations and made the introduction of DSS technology more "acceptable." One interviewee stated that "DSS is no longer a foreign concept – there is less of a belief that the computer is intruding on the work environment." Another interviewee stated that "people are more used to using computers to assist them in making decisions" and that this has "led to DSS implementation." This seems to suggest that the source selection community is becoming more open to DSS usage within the decision process.

The other research proposition supported by the interview data dealt with the whether these source selection experts foresaw DSS technology being implemented within the decision process. The interviewees supported the proposition that DSS technology will be implemented within the source selection process. Though the great majority of interviewees agreed that DSS would be implemented, they contradicted the author's belief as to where in the source selection process the DSS would provide the best utility. While the author believed that DSS would provide the greatest benefit to the SSA in the final decision between contractor's proposals, the interviewees almost unanimously believed that DSS technology would provide more utility to the lower levels of the decision process. They felt instead of a DSS, that a group decision support system (GDSS) should be used by the separate technical, contracting and managerial teams (SSET) to facilitate their assessment of the proposals prior to forwarding their evaluations to the SSA. This contradicted a key assumption of the author, namely that the SSA would use the DSS in the final decision. The interviewees repeatedly mentioned that a GDSS would assist in the "reaching of consensus," the communication, and the documentation within these specialized teams.

Summary

"Making adequate decisions over long time periods in a changing environment and subject to incomplete information, misinformation, uncertainty, and changing preferences is one of the central and most sophisticated human cognitive abilities" (Radermacher, 1994: 258). How we facilitate this decision-making process within the source selection arena is the focus of this study. Though the results failed to show the effects of DSS use on key decisional factors, valid conclusions can still be drawn from this study. Individuals involved in the source selection process have an improving perception of DSS and foresee its implementation within the decision-making process. They believe that GDSS technology should be implemented within the lower levels of the source selection organization (SSET).

The workplace is becoming increasingly interconnected via information technology such as the internet, LAN, intranet, etc. This technology of connecting computers together has shown to be advantageous to group decision making when used in conjunction with GDSS technology (McLeod 1997: 714). A study conducted by Gallupe et al. found that decision quality for groups using the GDSS was significantly greater than groups not using the system(Gallupe et al., 1988: 293). Gallupe et al. also noted that the difference in decision quality increased as task difficulty increased, providing evidence that GDSS's may provide the greatest value-added for difficult tasks (Gallupe et al. 1988: 277). Another study by Zigurs et al. also found that "the procedural efforts of CS [GDSS] groups were more effective than those of manual groups" and that the GDSS groups outperformed the manual groups (Zigurs et al. 1988: 641).

McLeod conducted another study of the benefits of GDSS use. This study stated that GDSS groups outperform face-to-face groups by reducing barriers to participation (McLeod et al., 1997: 706-707). Reasons for this improved performance are that GDSS technology eliminates the need for turn-taking, reduces apprehension to participation, and reliance on anonymity (McLeod et al., 1997: 707). The McLeod study found a relationship between the reduction in barriers to participation found in GDSS to overall group decision quality (McLeod 1997: 714). This study bases the improved group performance with GDSS technology on the improved participation of all group members in the GDSS configuration. Some group members who otherwise contribute little to group consensus building are more eager to contribute in the GDSS mode. The overall consensus within the literature is that GDSS technology improves decision quality, participation, and satisfaction (Eierman et al., 1995: 8-9).

The consensus of the interviewees was that GDSS technology would provide the greatest benefit to the source selection process and that the lower levels, namely the technical and contractual teams assessing the proposals prior to SSA, should utilize this technology. The perceived usefulness of GDSS technology by the interviewees is largely supported in the literature. The documented benefits of GDSS, along with the improved perception of DSS technology, point to a merging of technology and need within the source selection community. The utilization of GDSS technology within the source selection process has serious consequences to future source selections that must be examined further.

<u>Barriers to Technology</u>

Though source selection community perceptions of DSS technology have improved and they foresee its ultimate implementation, little has been done to actually bring this technology into this process. There must be some explanation for this. Since the source selection community, or at least those interviewed for this study, see the benefits of this technology but yet little has been done, there seems to be some organizational resistance. The theory of innovation diffusion attempts to explain this resistance to acceptance of information technology.

Innovation diffusion theory attempts to describe how any technological innovation moves from the stage of invention to widespread use. This theory posits five characteristics beneficial to the eventual widespread use: relative advantage, compatibility, complexity, trialability, and observability of outputs (Dillon and Morris, 1996: 6). Of these five characteristics, compatibility, complexity, and observability could be precluding the adoption of DSS. DSS seems compatible with the social practices and norms of those interviewed for this study but the power base in the source selection community is with the SSA's themselves and this technology may threaten their position and power. The complexity of DSS technology is another barrier for innovation diffusion. Though the technology was perceived favorably by most source selection individuals, there was some resistance expressed in the interviews to the increased complexity of the process and the DSS technology itself. Observability describes "the extent to which a technology's output and its gains are clear" (Dillon and Morris, 1996: 6). This presents another problem since with source selection decisions it is extremely difficult to quantify the improvement in selecting one proposal over another.

Attewell's view of innovation diffusion is that the burden of developing a technical know-how becomes the most significant hurdle to adoption (Attewell, 1992: 7). According to his view, the delay we are seeing in DSS implementation could simply be the result of the time needed to develop the technical "organizational learning required to implement and operate it successfully" (Attewell, 1992: 7).

The explanation for why this available and seemingly productive technology has yet to be introduced into the source selection community is multi-faceted. The delay can be explained by a combination of lacking organizational know-how and threats to power and position. Simply put, there is little corporate experience with developing, implementing, and operating decision support system technology within the Air Force. The development of an organizational knowledge base to inform the source selection community about the capabilities, demonstrate, and build support for eventual implementation is crucial. This group could ensure that the five characteristics of innovation diffusion theory are applied.

The final and biggest hurdle to DSS implementation is that it is perceived as a threat to individual power and position. The information gathered from the interview process seems to indicate a strong concern for how this technology will impact SSAs. They seem to protest the introduction of DSS technology not because of its capabilities or limitations but because of a perceived reduction in the subjectivity of their decision-making. DSS technology provides organized, clear information along with the ability to manipulate, compare, and display numerous alternative algorithms. The concern with

DSS is not how it will impact the decision itself but how it will impact SSA subjectivity and the position and power they derive from this subjectivity. Subjectivity of the source selection decision is an important component of the process and the concern about whether this component can coexist with the improved information provided by a DSS must be addressed. The SSA, as the most powerful component of the source selection community, must buy-in to DSS implementation for it to succeed. Whether this can be done remains to be seen but the possibility of eventual introduction is good when new, less technology-averse managers are promoted into positions of power.

Recommendations

Further research is certainly warranted in the area of decision support systems and their utilization in the source selection process. The author's recommendations for further research in this area are as follows:

-- Conduct an experiment simulating the assessment of proposals by the technical and contracting teams comparing GDSS use with non-GDSS use. Special attention should be paid to consensus building and its effect on decision quality, confidence, and satisfaction.

-- Conduct a survey of source selection officials to determine their perceptions concerning GDSS introduction at the SSET level within the source selection process.

-- Conduct an experiment with a more complex scenario to further investigate the effect of DSS on decision quality and decision subjectivity

-- Conduct a time series analysis of DSS use to investigate the "learning curve" effect.

This research revealed the improving perception of DSS technology within the source selection community. It also revealed that individuals involved with the source selection process believe that DSS technology will be introduced into the process. Clearly, more research is needed to assess what type of DSS should be implemented, what the effects are of such implementation, and how this technology can best be implemented so as to provide the optimal benefit.

Conclusions

The previous study which addressed this issue (Vickery, 1989) came up with many of the same conclusions as this study. DSS has been an available and proven technology for several years yet the source selection community has failed to incorporate this technology within the process. If DSS technology is to be implemented into the source selection process, the three characteristics of technology infusion that must be addressed are compatibility, complexity, and observability of outputs. A comprehensive education and training program as well as a pilot study can address these characteristics. The training and education of source selection personnel would increase the organizational know-how with respect to DSS while at the same time addressing the compatibility and complexity characteristics. The pilot study would allow source selection personnel to utilize the DSS in an actual source selection and address the observability of outputs. If the Air Force addresses these characteristics of technology diffusion, they will reap the benefits of DSS technology and ultimately provide better products and services to Air Force personnel.

Appendix: Telephone Interview Form

Introduction (AFIT, thesis description, computer-based DSS)
Gather Background Data
Current position?
Contracting experience?

1. What are your present concerns with the source selection process?

2. What can be done to improve the source selection process as you see it?

3. How have your feelings/perceptions about DSS changed during the last few years (5)?

4. Has increased computer competence and dependence opened the doors for DSS implementation in the source selection process?

5. Are you presently using a DSS within the source selection process?
   Y – Where in the process?
   - Are you addressing other areas within the process for DSS implementation?
   - Where did you get the DSS? (developed yourself, commercial off the shelf)
   - What is the impact of the DSS on the source selection process?
   N - Do you foresee DSS being implemented into the source selection process?
      Y – Where in the process?
      – Will it be used by the SSA?
   - Are you open to the possibility of using a DSS within your job?
      Y - What do you foresee its impact on the process?
      N – What do you foresee being lot with DSS implementation in the process?

6. How do you believe the use of a computer-based DSS by the SSA would impact the following decision criteria? (+,-)
   Decision time?
   Number of alternatives considered?
   Decision confidence?
   Decision satisfaction?
   Decision quality?

Bibliography

Alter, Steven L. Decision Support Systems: Current Practice and Continuing Challenges. Reading MA: Addison-Wesley, 1980.

Attewell, Paul. "Technology Diffusion and Organizational Learning: The Case of Business Computing," Organization Science, 3: 1-19 (February 1992).

Barr, Steve H. and Ramesh Sharda. "Effectiveness of Decision Support Systems: Development or Reliance Effect?" Decision Support Systems: 21: 133-146 (October 1997).

Campbell, Donald T. and Julian C. Stanley. Experimental and Quasi-Experimental Designs for Research. Chicago: R. McNally, 1966.

Cats-Baril, William L. and George P. Huber. "Decision Support Systems for Ill-Structured Problems: An Empirical Study," Decision Sciences, 18: 350-372 (Spring 1987).

Cooper, Donald R. and C. William Emory. Business Research Methods. 5th ed. Chicago: Richard D. Irwin, Inc., 1995.

Department of the Air Force. Air Force Federal Acquisition Regulation (AFFARS): Appendix BB. WWeb, http://farsite.hill.af.mil/reghtml/affars/apdx_bb.htm. 4 November 1997.

Dillon, Andrew and Michael G. Morris. "User Acceptance of Information Technology: Theories and Models," Annual Review of Information Science and Technology, 31: 3-32 (1996).

Eierman, Michael A., Fred Niederman, and Carl Adams. "DSS Theory: A Model of Constructs and Relationships," Decision Support Systems, 14: 1-26 (January 1995).

Emory, C. William. Business Research Methods. St. Louis: Richard D. Irwin, Inc., 1980.

Gallupe, R. Brent, Gerardine DeSanctis, and Gary W. Dickson. "Computer-Based Support for Group Problem-Finding: An Experimental Investigation," MIS Quarterly, 12: 277-296 (June 1988).

Hogarth, Robin M. Judgement and Choice. New York: John Wiley & Sons, 1987.

James, Kathleen A. "Everything a Source Selection Authority (SSA) Ever Wanted to Know About Source Selection (But Was Afraid to Ask)," WWeb, http://www.afmc.wpafb.af.mil/HQ-AFMC/PK/pkx/training/smsswksp/ssagd.htm.

Keen, Peter G. W. "Decision Support Systems: A Research Perspective," in Decision Support Systems: Issues and Challenges. Ed. Göran Fick and Ralph Sprague. New York: Pergamon Press, 1980.

Mackay, Jane M., Steve H. Barr, and Marilyn G. Kletke. "An Empirical Investigation of the Effects of Decision Aids on Problem-Solving Processes," Decision Sciences, 23: 648-671 (May/June 1992).

McLeod, Poppy Lauretta, Robert S. Baron, Mollie Weighner Marti, and Kuh Yoon. "The Eyes Have It: Minority Influence in Face-To-Face and Computer Mediated Group Discussion," Journal of Applied Psychology, 82: 706-718 (Oct 1997).

Miller, George A. "The Magical Number Seven Plus or Minus Two: Some Limits on Our Capacity for Processing Information," The Psychological Review, 63: 81-97 (March 1956).

Mintzberg, H., D. Raisinghani, and A. Theoret. "The Structure of 'Unstructured' Decision Processes," Administrative Science Quarterly, 21: 246-275.

Radermacher, F. J. "Decision Support Systems: Scope and Potential," Decision Support Systems, 12: 257-265 (July 1994).

Schroeder, Roger G. and Izak Benbasat. "An Experimental Evaluation of the Relationship of Uncertainty in the Environment to Information Used by Decision Makers," Decision Sciences, 6: 556-567 (Summer 1975).

Sharda, Ramesh, Steve H. Barr, and James C. McDonnell. "Decision Support System Effectiveness: A Review and an Empirical Test," Management Science, 34: 139-159 (February 1988).

Simon, Herbert A. Administrative Behavior: A Study of Decision Making Processes in Administrative Organizations. 3rd ed. New York: The Free Press, 1976.

----. Models of Bounded Rationality: Behavioral Economics and Business Organizations. Cambridge MA: The MIT Press, 1982.

----. The New Science of Management Decision. Rev. ed. Englewood Cliffs NJ: Prentice-Hall, 1977.

Tversky, Amos and Daniel Khaneman. "Judgement Under Uncertainty: Heuristics and Biases," Science, 185: 1124-1131 (1974).

----. "Availability: A Heuristic for Judging Frequency and Probability," Cognitive Psychology, 4: 207-232 (1973).

Vickery, Caisson M. The Use of Computer-Aided Decision Support Systems for Complex Source Selection Decisions. MS Thesis, AFIT/GCM/LSY/89S-15. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1989 (AD-A216422).

Watson, Richard T. Gerardine DeSanctis, and Marshall Scott Poole. "Using a GDSS to Facilitate Group Consensus: Some Intended and Unintended Consequences," MIS Quarterly, 12: 463-477 (September 1988).

Wierenga, Berend and Gerrit H. van Bruggen. "The Dependent Variable in Research Into the Effects of Creativity Support Systems: Quality and Quantity of Ideas," MIS Quarterly, 22: 81-86 (March 1998).

Zigurs, Ilze, M. Scott Poole, and Gerardine L. DeSanctis. "A Study of Influence in Computer-Mediated Group Decision Making," MIS Quarterly, 12: 625-644 (December 1988).

Vita

Captain Matthew L. Decker was born on 15 October 1970 in Glens Falls, New York. He graduated from Queensbury High School in Queensbury, New York in June 1988. He entered undergraduate studies at the United States Air Force Academy in Colorado Springs, CO where he graduated with a Bachelor of Science in Geography and received his commission in June 1994.

His first assignment was at Hill AFB in the 75th Air Base Wing where he served as arms control analyst for the Arms Control Office. In October 1996 he was assigned to the 75th Communications Squadron where he served as executive officer. In March 1997, he entered the Graduate Information Resource Management program, School of Logistics and Acquisition Management, Air Force Institute of Technology. Upon graduation, he will be assigned to the Air Force Communications Agency at Scott AFB, Illinois.

Permanent Address: 18 Dorset Place
Queensbury, NY
12804

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1998	Master's Thesis

4. TITLE AND SUBTITLE

COMPUTER-BASED DECISION SUPPORT SYSTEM USE IN CONTRACTING'S SOURCE SELECTION PROCESS

5. FUNDING NUMBERS

6. AUTHOR(S)

MATTHEW L. DECKER, Capt, USAF

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)

Air Force Institute of Technology
2950 P Street
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GIR/LAS/98S-1

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 Words*)

This thesis examines the use of decision support system (DSS) technology within the U.S. Air Force's contracting source selection process. DSS technology has been shown to be an effective aid to complex decision processes such as source selection decisions and the possible effects of utilizing this technology are the focus of this study. Conclusions drawn from this thesis may guide the contracting community to readdress the possibility of implementing DSS technology within the source selection process.

This study evaluated statistical data from a previous experiment to determine the effect of DSS use on time, confidence, and decision quality. This study also included interviews of individuals involved in the source selection process to determine their perceptions of DSS technology. It was found that the perception of DSS technology within the source selection community has improved within the last five years. It was also found that source selection experts foresee DSS implementation within the source selection process within the near future. In fact, the source selection experts interviewed believed that group DSS would provide the greatest benefit to the process. Possible explanations and implications of this discovery are provided.

14. Subject Terms
Decision Support Systems, DSS, Contract Proposals, Contracts, Management Information Systems

15. NUMBER OF PAGES
88

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

AFIT Control Number AFIT/GIR/LAS/98S-1

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. **Please return completed questionnaire** to: AIR FORCE INSTITUTE OF TECHNOLOGY/LAC, 2950 P STREET, WRIGHT-PATTERSON AFB OH 45433-7765. Your response is **important.** Thank you.

1. Did this research contribute to a current research project? a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?
a. Yes b. No

3. **Please estimate** what this research would have cost in terms of manpower and dollars if it had been accomplished under contract or if it had been done in-house.

Man Years____________ $____________

4. Whether or not you were able to establish an equivalent value for this research (in Question 3), what is your estimate of its significance?

a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments (Please feel free to use a separate sheet for more detailed answers and include it with this form):

______________________________ Name and Grade

______________________________ Organization

______________________________ Position or Title

______________________________ Address