A FOUR FACTOR MODEL FOR THE SELECTION OF A SYSTEMS DEVELOPMENT APPROACH

BY

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ABSTRACT

The purpose of this research was to develop a model which would aid in selecting the best systems development approach for supplying a decision maker with a computer based support system. The research proceeded in several stages.

First a hierarchical model was developed. The "top" level of the model described situations in terms of four factors or meta-constructs; User Participation in the Decision Making Process, Problem Space Complexity, Resource Availability and Organizational Context. The set of factors was based on Churchman's systems theory and the organizational interaction represented by the Leavitt Diamond. In the "lower" level the factors were each described by a set of attributes. The list of attributes was based on a literature search, aided by a model developed by Ginzberg and Stohr.

Next the model was validated in a three phase process. The first phase involved validation of the model structure and content. A normative group technique (Delphi method) was chosen to obtain expert consensus on both the factors and the attributes that defined them.

The second phase of the validation aided in content validation of the lower level of the model and associated a factor value with each unique set of attribute levels. It consisted of two sets of case-based interviews. Two of the factors had been defined as managerial in nature and these interviews were conducted with senior administrative personnel. The other two factors had been defined as technical in nature and the subjects of these interviews had a systems background.

The third phase of the research aided in content validation of the "top" level of the model and determined which approaches were preferred in which situations (unique set of factor values). It consisted of a set of case-based interviews with senior MIS personnel (including experienced academics) to assign the "best" or "preferred" approach to each of the situations (set of factor values).

Based on the results of these studies we have shown that it is possible to define situations in terms of a hierarchically ordered set of attributes, for the purpose of determining how best to provide computer based support for the decision maker facing a particular situation.

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Finally I would like to thank my wife and son, who put up with a part-time student, part-time husband and part-time father for the past eight years for the help, encouragement and patience they have shown. I dedicate this thesis to them.

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CHAPTER 1

INTRODUCTION

1.0 DECISION MAKING IN A MANAGERIAL CONTEXT

The responsibility for decision making rests with those who have the authority to make and implement decisions, rather than with those who supply the decision maker with information, or provide him/her with counsel. Because of this direct responsibility one expects the decision maker to possess a desire to make the best possible decision. The discipline of Management Science is predicated on the need for decision makers to make the best possible decisions. In the real world this is often translated into making better decisions, assuming that better or best in this context can be defined.

For the purpose of this research it was necessary to define what was meant by "better" decisions, or the "best" decision in a managerial context. Better, preferred, appropriate and other similar terms imply a value judgment. The basis for the judgment used in this paper is that adopted by Vroom [1973], which is that the effectiveness of managers is defined in terms of their track record of making the "right decisions", from an organizational perspective. Better decisions are those which when considered over the long term can be viewed as more beneficial from the organizational viewpoint. Therefore systems which support decision makers should help them make more of the "right" decisions or help them make better individual decisions consistently so that their "track record" improves.

Sanders [1984] attempted to develop a measure for DSS/MIS success and identified two meta-factors for this: organizational effectiveness and member welfare. He pointed out that while one hopes that these are linked, there is no universally accepted proof that this is so.

When discussing the first meta-factor, organizational effectiveness, Sanders [1984] cited how Huber [1981] linked organizational goal achievement and the quality of individual decision making. This suggests that the best individual decisions are those which lead to the best organizational outcomes in the long run (increase organizational effectiveness). Even though criteria may vary between organizations as to what constitutes the best decisions, this means that, if an information system is to be effective in supporting a decision maker(s), it should aid that decision maker(s) in consistently making better decisions.

The second meta-factor suggests that it is important that information systems not have a negative impact on the welfare of the individual decision maker. This is especially true for the case of managerial decision makers who are discretionary system users and have a choice in selecting the tools to perform their jobs (Lucas [1975], Methlie [1983]). They will either ignore a system which they perceive as not helping them, or make only token use of it (i.e. go through the motions of using it in a fashion similar to that described by De Brabander and Thiers [1984] for user participation in systems development).

If both organizational and member welfare are to be positively related to better decisions, then the goals of the organization and of the individual must converge. That is: A) the individual in general will not benefit in the long term from decisions which consistently are not in the organization's best interests, and B) the organization will not benefit in the long run from decisions which are consistently against the best interests of its members.

For the purposes of this research the definition of best or better decisions assumes that in general, decisions that are in the organization's best interests, over time are in the decision maker's best interests as well. In addition to defining what a better decision is, we also need to describe a framework for the decision making process itself to aid our understanding of how to support this process.

1.1 A FRAMEWORK FOR DECISION MAKING

One widely accepted model of human decision making is that presented by Simon [1960]. It classified decisions as ranging continuously from programmable (structured) to nonprogrammable (unstructured). Programmed decisions are defined as being repetitive or routine, such as the determining of salary payments to employees who have been ill. Nonprogrammed decisions are those which are novel or unstructured and consequential. In some sense they are seen as the overall decision making process, not merely the final act. Simon said [1960 p 6]:

"General Eisenhower's D-Day decision is a good example of a nonprogrammed decision. Remember, we are considering not merely the final act of ordering the attack, but the whole complex of intelligence and design activities that preceded it. Many of the components of the decisions were programmed - by standard techniques for military planning - but before these components could be designed they had to be provided with a broader framework of military and political policy."

Simon also described the decision making process as consisting of three phases, intelligence, design and choice.

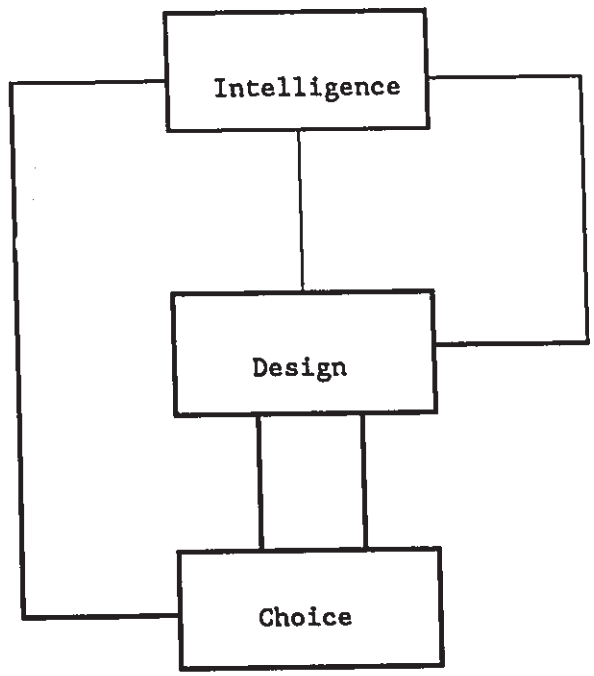
The intelligence phase of the decision making process refers to the initial procedures where the environment is scanned for problems and related information. The design phase involves inventing, developing, and analyzing possible solutions to the problems presented by the preceding stage. The choice phase refers to the selection of the best of the alternatives generated in the previous phase.

Although the above description appears to define a linear process, moving smoothly from one phase to the next, this is not the case. The process of decision making involves a great deal of backtracking and iteration, with feedback from one phase capable of causing a re-evaluation of the outputs of preceding phases (See Figure I). Or as Simon [1960 pg. 3] said:

> " The cycle of phases is, however, far more complex than the sequence suggests. Each phase in making a particular decision is itself a complex decision making process. The design phase, for example, may call for new intelligence activities; problems at any given level generate subproblems that in turn have their intelligence, design, and choice phases, and so on. There are wheels within wheels..... Nevertheless, the three large phases are often clearly discernible as the organizational decision process unfolds."

Other studies into decision making have confirmed that these phases can be identified, but that they are interleaved and interactive (Carlson [1983]).

Simon's model of decision making has been used by many authors to develop frameworks and discuss computer based support of decision making (i.e Gorry and Scott Morton [1971], Sprague and Carlson [1982], Davis and Olson [1985], Luconi et al [1989], Sabherwal and Grover [1989]). Therefore, while there may be many other models (or frameworks) for decision making, since a great deal of the relevant information systems literature makes use of the Simon model, we have also used it.



SIMON'S MODEL OF DECISION MAKING
FIGURE I

Although Simon's model has formed the basis for a great deal of research computer based support for decision makers, it has been adapted by many of the authors who have used it. For example, Sprague and Carlson [1982], Mittman and Moore [1989], and others have suggested that the implementation of the decisions should be considered as a separate phase of the decision making process, since it may need a different type of support than the other phases. Similarly, Simon's original description of decisions as ranging from programmed to non-programmable has been adapted by many writers.

Keen and Scott Morton [1978] renamed the endpoints of the scale as structured and unstructured in an attempt to relate less directly to the computer. They also described a middle ground, semi-structured decisions. To do this they made use of two concepts; the concept of perceived structure and deep structure, and that of the phases of the decision making process. They noted that problems often appear to be unstructured, but if studied carefully, they can be shown to be structured, or at least to contain structured subproblems. This however leads to the question of context. Given the state of knowledge a given decision maker possesses, or the time a given decision maker has to spend on a problem, that problem may be perceived to be unstructured, while in fact it may possess underlying structure or has structured sub-problems.

Similarly, if one looks at the stages of the decision making process independently, then it may be that one stage of the process is well defined or structured, while another is ill defined. In the situation where all the phases are structured, then we can define algorithms or rules to allow us to find the problem, design the alternatives and finally to select the best alternative. This is a structured problem. At the other extreme where all phases are unstructured, it is not clear how to gather information about the problem or even how to define the problem, there is no clear cut method for developing alternatives, and no clear criteria for choosing among alternatives. This is an unstructured problem.

A semi-structured problem would then be one where either one or more, but not all phases of the decision making problem are unstructured, or where it is perceived that that are subproblems of the overall problem that are unstructured.

Luconi et al [1989] have extended this by looking at four characteristics of problems (the data, the procedures, the goals and constraints, and the strategies used to decide which procedures to use). A fully structured problem is one where all four elements are structured i.e. there are well-specified data, the goals are well and clearly stated and there exist standard procedures for solving the problem, and hence no need for flexible strategies to select the problem solving procedures. As problems become less structured there may be no straightforward solution techniques, or the data may be incomplete or ill specified, or the goals and constraints unclear. In the extreme, unstructured problems are those that possess only unstructured characteristics.

Young [1989] also recognizes the difficulty in differentiating between structured and unstructured problems, and uses a different set of problem characteristics to differentiate between them. These are: the objectives, outcome affecting variables, and the relations between the outcome affecting variables.

The field of Organizational Behavior has provided other relevant definitions. Wood [1986] has attempted to develop a model for describing tasks and how they differ from one another. He states that tasks contain three essential components: products, required acts and information cues. He defines complexity as a function of three types of complexity: component, coordinative and dynamic. The component complexity has to do with the number of distinct acts that need to be performed. The coordinative complexity has to do with the nature of the relationships between the task inputs and the task products. The dynamic complexity has to do with the changes in the states of the world affecting the relationships between task inputs and products.

For this research we will define the problem solving process as consisting of three phases: intelligence, design and choice. We will define problems as ranging from structured to unstructured. We will also define the four problem characteristics as: data, procedures, goals and constraints, and the strategies used to decide which procedures to use. The task of problem solving for a particular class of problems will be defined as more or less complex based on the task characteristics of the problem solving tasks normally found in that environment; i.e. the number of non repetitive tasks involved, the number and type of relationships between the task inputs and the task products, and how these relationships change with time.

1.2 RESEARCH JUSTIFICATION

The principal justification for undertaking this research is the need to improve the delivery of computerized support to decision makers. An expected corollary of the research is the development of increased understanding of the decision making process, particularly the interaction between the current strategies for supplying computer support and the decision making process. It is our contention that to improve the process of supplying computer-based support one must be able to: 1) determine the actual needs of the user(s), 2) determine how different users make use of support tools, and 3) determine how to distinguish among different categories of users.

This research attempts to classify users in terms of the decision making or problem solving situations that they are faced with. Based on the characteristics of those situations the model being developed then would suggest an approach to supplying computer-based support systems that would increase the probability of a successful implementation of that support system. Underlying this research is the assumption that if we can distinguish different categories of users, then all users in that category can be treated similarly. Therefore the characteristics of the situation will include both the user needs, and something about how the user would make use of a support tool.

This research is based on the premise that if one can determine how a given decision maker should be supported, then one could improve upon the delivery of that support. Improved delivery could include such factors as increased user acceptance, lower cost of delivering the service, or improved effectiveness of the decision maker using the CBIS.

1.3 GENERAL ORGANIZATIONAL PROBLEMS CAUSED BY CBIS

CBIS were developed because of a presumed need for better information support to make better decisions. Improperly designed CBIS can impede or distort the flow of information in the organization. Some of the possible problems described in the literature include :

1) Decrease in The Flow of Information to Senior Management.

The use of Management Information Systems can be disfunctional since they can lead to an increasing concentration on the upward flow of information in the organization, at the expense of the corresponding downward flows (Hopwood and Earl [1980]) and a potential boycott of the formal information systems by members at the lower levels of the organization.

Similarly Argyris [1980] talks about the problem of over-control; the more we try to control our organizations by means of formal information systems, the less likely we are to succeed. Here, formal information systems are " manifested by documents and other records, usually indicating compliance with prespecified rules and procedures" (Davis and Olson [1985] p 50). The use of formal information systems in this fashion is likely to result in the institutionalization of injustices, with accompanying diminished employee loyalty and performance and the resulting reduction in the quality and/or quantity of upward information flows.

2) Decreased Attention to Critical Issues.

Bureaucratic rationalization occurs when the focus of the organization shifts from the external environment to its internal structure, because of the disproportionately large volume of internally generated data that is available (Hopwood and Earl [1980]). This in turn leads to sub-unit goals which are measured in terms of the formal systems outputs rather than in terms of real productive measures, because the real measures are often difficult to quantify and report in a fashion compatible with most "hard data" based CBIS.

Supplying decision makers with a decision support system can have disfunctional consequences (Bosman [1983]) in that it can increase the emphasis on generating action alternatives, and increase the problem of coordination in decision making tasks.

3)Focus on Formal Channels.

Mintzberg [1972] suggested that most top managers receive their information via informal rather than formal channels. Computer-based support systems for high level decision makers can create problems if these systems represent an attempt to enforce a reliance on the formal information systems. They may then represent an attempt to change how users make their decisions.

Methlie [1983] has suggested that Decision Support Systems can alter the power structure in an organization. DSS do this by providing certain individuals with increased power, based on their relation to the new technology, rather than on their organizational roles or conscious senior management decisions to alter the power structure in the organization.

In the extreme this can lead to the support of a "one right way of doing things" type of approach in an organization as decision makers become reliant on the formal information systems, and the available computer-based analysis tools. This may in turn reduce the organization's ability to handle different or unique situations. Often the strategic use of information systems involves looking at different ways of approaching common problems. Sprague and McNurlin [1986] gave an example of a manufacturing firm with a central plant and warehouse and various distribution centers trying to increase the return on investment (ROI). The application of standard techniques to reduce inventory resulted in plans that would slightly increase ROI. When challenged to be creative, they found that a totally unique and different approach was the best way to improve the ROI. Their solution was to eliminate the central warehouse altogether, and install an improved computer-based distribution system. Peters and Waterman [1982] have also stressed the importance of non-traditional solutions to problems (allowing or encouraging employee discretion in problem solving).

4) Opportunity Cost of Failed Systems

The cost of developing support systems for decision makers has been justified by the existence of a high payback which would offset the costs of development and implementation of these systems (Keen and Scott Morton [1978]). The existence of potential gains also creates an opportunity cost if the system implementation is a failure, or if it is only marginally successful.

More recently, several authors have written about a second type of opportunity cost when they have discussed the use of information systems for competitive advantage (e.g. Sprague and McNurlin [1986], Wiseman [1988], Cash et al [1988]). Sabherwal and Grover [1989] attempt to provide a framework for computer based support of these strategic decisions, (that is for Strategic Information Systems (SIS)) stating the need to provide the correct SIS in each situation. They all indicate the large possible benefits of the use of CBIS for strategic decision making.

One key example of the strategic use of IS is the total redesign of organizations that properly designed and utilized IS can facilitate. Drucker [1989] talks about the positive changes that will take place in organizations that learn to use information rather than data. He speaks of the benefits of removing the layers of analysts and middle managers and creating new organizations that are smaller, and have flatter structures. Similarly, Keen [1989] states that by the year 2000 the use of Information technologies will shift from economic health (gaining a competitive advantage) to organizational health. This is consistent with Peters and Waterman [1982] who suggest that successful organizations stay successful by avoiding the development of complex organizational rules and procedures. Companies that do not take advantage of these opportunities may find the opportunity cost is their continued existence.

1.4 SUMMARY

This research will be valuable if it can improve the delivery of computerized support. Improving the delivery of support services is important (Burns and Dennis [1985]) as the cost of supplying these services is high. This cost includes:

- the actual cost of development and implementation of the technology (which is continually becoming less and less of a major factor (Benjamin and Scott Morton [1988])),
- the organizational costs of implementation
- the opportunity cost associated with sub-optimal decision making,
- the organizational costs of having to repair or replace a (CBIS) that is not working properly.

Strassman [1989] details many of these hidden organizational implementation costs when discussing the true cost of Office Automation.

The increasing use of computers will no doubt affect the decision making process itself. The better we understand how the process is affected, the better we will be able to manage this change. Research in this area is a step in the process of learning how to supply computerized support to decision makers in the most efficient fashion. This research suggests that this can be accomplished only by considering a wide variety of situational factors. This is congruent with Ginzberg and Ariav [1984] who suggested that:

> " A key direction for future research is gaining a better understanding of the range of DSS environments and roles...... Further work is needed , however to develop a design relevant taxonomy of DSS environments identifying key environmental characteristics and the constraints they place on the choice of DSS components, their arrangement and the resources required."

Furthermore this research is based to some extent on research into the decision making process itself. Vroom [1973] and Vroom and Jago [1978] have suggested that certain types of decision making are appropriate in certain situations. If there are different ways to approach decision making in different situations, should there not be different means of supplying computerized support for these situations?

There is no one way of ensuring that support systems will be beneficial in all instances. There exists a large body of Information Systems literature which attempts to define how to minimize the negative organizational consequences of implementing information systems (Mumford and Weir [1979], De Maio [1980], Oppelland and Kolf [1980], Land et al [1980], Huber [1984]). This research has a place in this tradition in that it attempts to define which of a set of approaches to decision support would be more appropriate in a given situation. Similarly this research continues the tradition of contingency modeling. It seeks to explain how particular types of systems may be developed, or how to select between different methodologies at various stages in the systems development life cycle (Taggert and Tharpe[1975], Davis [1982], Ein-Dor and Segev [1978], Mann and Watson [1984], Naumann et al [1980], Sage [1981], McKeen [1983], Burns and Dennis [1985]).

CHAPTER TWO

DEVELOPMENT OF THE FOUR FACTOR MODEL

2.0 INTRODUCTION

This research was based on three assumptions. The first, that it is possible to define various strategies or approaches for the development of computerized support for decision makers. The second, that it is possible to define situations using a set of factors which are each defined by a set of attributes (situational variables). The third, that some approaches are preferred or more suitable in a given situation (set of factor values) than others. These assumptions are founded on the concept that approaches for developing support systems should be tailored to situations. This is based on a similar concept which has been accepted in the literature (Silver [1988]) that DSS should be tailored to situations. Symbolically this may be represented as:

$$F(\{X_i\}) \text{ ----------> } \{Y\}$$

where

$\{X_i\}$ - PRESENT SITUATION subset of {FACTOR VALUES}

$\{Y\}$ - APPROPRIATE APPROACH(ES) subset of {APPROACHES FOR SUPPORT SYSTEMS DEVELOPMENT}

There may be more than one approach that is appropriate in a given situation.

The four factor model developed in this research (Fig II) has been defined in a hierarchical fashion, where the factors in the model serve as both independent and dependent variables at different levels. At the top level of the model, each situation is defined as a unique set consisting of a value for each of the four factors $\{X_i\}$. These sets of factor values are then matched to approaches $\{Y\}$. At the more detailed level in the model, each factor value is itself associated with at least one set of attribute levels.

Although the final list of factors and their defining attributes was defined by means of expert consensus, an initial set of "seed" definitions were needed as inputs into this process. Since better quality input meant an easier process of obtaining consensus and better output from this process, it was necessary to develop these initial definitions carefully. The overall dependent variables, (approaches to developing computer based support systems) are defined in section 2.1. The independent variables, (the factors and their defining attributes) are defined in section 2.2.

SYSTEMS DEVELOPMENT APPROACHES

NULL APPROACH

SYSTEMS DEVELOPMENT LIFE CYCLE APPROACH

PROTOTYPING APPROACH

DECISION MAKER CENTRED APPROACH

DECISION MAKING SYSTEMS APPROACH

FACTOR I USER PARTICIPATION	FACTOR II PROBLEM SPACE COMPLEXITY	FACTOR III RESOURCE AVAILABILITY	FACTOR IV ORGANIZATIONAL CONTEXT
-USER ROLE	-UNIQUENESS	-AVAILABILITY OF HUMAN EXPERTISE	-ORGANIZATIONAL HISTORY
-USER PARTICIPATION /SOLICITATION	-PROBLEM SET COMPLEXITY	-DEVELOPER TASK COMPREHENSION	-ORGANIZATIONAL RESISTANCE TO CHANGE
-USER DISCRETION	-DATA RESOURCE COMPLEXITY	-USER SYSTEMS DEV. COMPREHENSION	-OFFICIAL ENDORSEMENT
-PROBLEM IMPORTANCE	-RANGE OF PROBLEMS	-AVAILABILITY OF TECHNOLOGY	-ORGANIZATIONAL ENVIRONMENT
	-INTERDEPENDENCE OF DECISIONS	-AVAILABILITY OF TIME	
	-PROBLEM STRUCTURE	-AVAILABILITY OF SYSTEMS PERSONNEL	

FIGURE II

2.1 THE APPROACHES FOR SUPPLYING COMPUTER-BASED SUPPORT SYSTEMS

We will define an approach for supplying computer-based support in terms of both the type of system provided and the level of participation of the end user in the systems development process.

At this stage only generalized approaches are used, even though if this tool were to be used in practice it would need to be fine-tuned to the set of methodologies available in a given firm. This is similar to the procedure used by G. Davis [1982] in developing a contingency model for selecting a strategy for information requirements analysis, and that used by Burns and Dennis [1985] for selecting one of three generalized approaches to systems development. These models can be contrasted with one that has been developed for a chemical company in the U.S. (Rhudy et al. [1986]) for actually selecting one of that company's development methodologies for use in a particular situation.

It is possible to look at systems development approaches from several perspectives. We have defined and maintained a user perspective, as opposed to either a developer (or tool-oriented) perspective, or a reference discipline perspective. This meant that when we considered the development of the various systems or the philosophy behind these approaches for support systems development, we attempted to do so in the context of the effect on the end user. Our seed definitions of the dependent variables also reflected this "bias". This bias is justified because of the importance of designing information systems from an end user perspective.

It is necessary to understand the philosophy as well as the content of an approach before one can understand how to use it appropriately. In the following section we will outline both the evolution of information systems used for the support of managerial decision makers, and the evolution of the different approaches for developing these systems.

2.1.1 COMPUTERIZED SUPPORT FOR DECISION MAKING

Much of the following discussion and description of the types of Information Systems is based on material that can be found in many standard sources such as Senn [1982], Sprague and Carlson [1982] and Davis and Olson [1985]. More recent works by Sprague and McNurlin [1986], Wiseman [1988], Gray et al [1989], Bidgoli [1989] and others also expand on some of these issues.

Early EDP systems were often referred to as transaction processing systems (TPS) because this adequately described their function which was the processing of organizational transactions (e. g. journal entries). They represented an automation of clerical functions and provided little if any support for managerial decision making. Sprague and Carlson [1982] state that these systems provide support for the intelligence phase of the decision making process. They do this by improving the data gathering activities. By making transaction processing more efficient they provided management with operational reports that were more complete and timely than before. The new systems also appeared to consume fewer organizational resources while producing these reports (Wiseman [1988], Davis and Olson [1985], Senn [1982], Sprague and Carlson [1982]). TPS were superseded by more sophisticated systems with integrated data files which allowed them to provide more comprehensive reports. In time, data base-centred information retrieval systems appeared which offered some level of on-line query facility for managers. As the systems became more sophisticated, the term Management Information Systems began to be used (Aron [1976]).

Management Information Systems (MIS) have been defined as supporting all three phases of the decision making process (intelligence, design and choice) (Davis and Olson [1985]). However, in practice they appear to provide the decision maker with better access to information, and some simple computational facilities, leaving the design and choice phases of the process relatively unsupported (Keen and Scott Morton [1978], Bonczek et al [1981], and Sprague and Carlson [1982]). Other authors have defined them as providing support for structured decision making processes (Wiseman [1988], Turban and Schaeffer [1989])

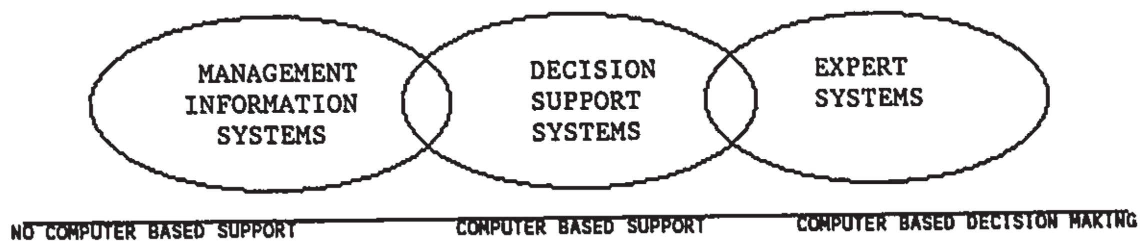
Management Science/Operations Research provides the manager with models for problem description and decision making (Burns and Austin [1985]). Since the late 1950's the computer has been used to provide the computational power to deal with more sophisticated models and increased amounts of data as managers attempt to cope with an increasingly more complex environment (Holloway [1979]). Models and associated data may be used to create Decision Support Systems (DSS). DSS represent an attempt at explicitly providing support to all phases of the decision making process (which few MIS appear to do (Sprague and Carlson [1982])). Emphasis is on the design and choice phases of the decision making process (Keen and Scott Morton [1978], Sprague [1980], Bonczek et al [1981] and Ginzberg and Ariav [1984]). Often they are defined in terms of providing support for the unstructured or semi-structured processes (Cats-Baril and Huber [1987], Luconi et al 1989] and many others).

Another approach for providing managerial decision support has developed from the narrower perspective of Artificial Intelligence (AI) (Blanning [1984], Pau [1986], Luconi et al [1989]). Simon's work on decision making was part of a larger effort directed at understanding and emulating human cognition. One offshoot of AI research was a different approach to supporting the decision making process, the expert systems approach. This approach supplants the human decision maker with an automated counterpart which supplies suggested solutions to the human who, in effect, becomes a decision ratifier (who either accepts or rejects a system generated solution) (Michie [1982], Hayes-Roth et al [1983], Lee [1983], Winston [1984], Henderson [1987]).

2.1.2 THE DEPENDENT VARIABLE: DEVELOPMENT APPROACHES

Some of the ways in which computers have been used to aid decision makers have been introduced in the previous section. A continuous set of alternatives for supplying computerized decision support can be visualized (Alter [1980], Sanders [1984]). One endpoint can be labeled as no computerized support of the decision making process. The other could be labeled as complete computer control of the decision making process; i.e. computerized decision making (Figure III). Along this continuum the complete range of techniques for supporting decision makers could be placed.

Three specific methods in which support has been provided for decision makers have been outlined; Management Information Systems (MIS), Decision Support Systems (DSS) and Expert Systems (ES). Although there are no precise definitions for what is meant by these terms, there appears to be agreement that there are different types of IS. Also there appears to be agreement that in general we can differentiate between the level of "support" for the decision making process provided by the different types of systems. (Bidgoli [1989], Alter [1980], and others differentiate between EDP/MIS and DSS, Luconi et al [1989], Henderson [1987], and Turban and Watkins [1986] compare/contrast DSS/ES).



CONTINUUM OF CBIS
FIGURE III

In the manner of Alter [1980] or Wiseman [1988] we could consider these three concepts (MIS, DSS, ES) to represent three sets which overlap (Fig III), in that there are no firm boundaries between MIS and DSS or DSS and ES. Alter stated that EDP systems and DSS's are by no means mutually exclusive, and that there was no point in belaboring the degree of overlap or non-overlap between them. Similarly we should concentrate on the different ways of supporting decision making that these various definitions represent. For the purposes of our current research we will use existing definitions of these types of IS to generate three archetypal systems for supporting decision makers.

We will then use these archetypal system types to define approaches to supporting decision makers, where an approach is defined as being composed of the end product (the system itself) and the level of end-user participation in the implementation. It is believed that many computer-based approaches currently in use for aiding decision makers could be associated with the set of approaches we will derive.

The three archetypal systems for supporting decision makers are:

(1) Organizational Information Systems (OIS),

(2) Decision Maker Centred Systems (DMCS),

(3) Decision Making Systems (DMS),

and they will be defined in the following section.

2.1.3 DEFINITION OF THE SYSTEM TYPES

As Wiseman [1988] states, the term MIS has never been defined to everyone's satisfaction. However, despite the lack of definition for the term MIS, we can identify common functions from definitions presented by many authors (e.g. Keen and Scott Morton [1978], Sprague and Carlson [1982], Wiseman [1988]). We will define an OIS as being capable of:

(1) Processing transactions

(2) Maintaining master files

(3) Producing fixed format reports

(4) Processing simple inquiries.

An OIS is a large scale organizational or multi-user system which performs clerical tasks such as transaction processing and maintaining files. It is also capable of producing routine reports and responding to simple inquiries. In general it provides the user with information rather than analysis capability.

Similarly there is no consensus as to what a DSS is. We will define a DMCS based on common features of definitions for DSS presented by many authors (e.g. Keen and Scott Morton [1978], Ginzberg and Stohr [1982], Sprague and Carlson 1982], Sprague and McNurlin [1986], Bidgoli [1989]). A Decision Maker Centred System is a system designed specifically to aid a decision maker (or a group of decision makers) by providing the decision maker with both data and support for the analysis and presentation of that data. It may aid the decision maker in the collection of information necessary to make a decision, by providing access to corporate databases or by providing an internal database. These systems are designed to support, not replace managers in their decision making activities, and they are aimed at supporting decision makers who are faced with unstructured or semi-structured tasks. Typically use of these systems will involve substantial manipulation of data, usually by means of sophisticated models. In a real sense the decision maker through his interaction with the DSS becomes an integral part of the problem processing system.

A Decision Making System (DMS) is a system which is designed to provide a decision ratifier with a proposed solution to a given problem which can either be accepted or rejected. A decision ratifier is defined as a decision maker whose role in the decision making process is limited to either accepting or rejecting a proposed solution. As such a decision ratifier is not normally involved in the actual decision making process. With a DMS the user is reduced to a decision ratifier, and since the system would normally select both the data resources and the problem solving techniques used, the user is very dependent on the system.

These systems differ from OIS in that they are aimed at the same types of decision making situations as the DMCS; i.e. those that are semi-structured or unstructured whereas OIS automate the structured parts of the overall problems. Another way of expressing this is to note that DMS are useful in solving problems that require "expertise", (Hayes-Roth et al [1983], Blanning [1984]), or problems where "all possible situations and outcomes are not known or cannot be explored beforehand" (Sprague and McNurlin [1986] p 379). This differentiates them from decision table programmes. A further differentiation is that in a DMS the knowledge base upon which the decision are based is separate from the "inference engine" (which consists of the programs which perform the selection of the proposed solution). This allows simplified creation, maintenance and updating procedures for what may be very large and complex knowledge bases.

We can make use of one of the examples cited by Simon [1960] to emphasize the differences among these three system types, as follows:

An example of an OIS is a payroll system. It processes transactions, updates files, produces regular monthly reports and automates programmed or structured decision processes by determining the proper pay for each employee.

An example of a related DMCS would be the Compensation module of an Human Resource Information System. This module allows access to salary and benefit data, provides access to modeling packages to perform various types of statistical analysis of salaries of various categories of employees, provides the tools to allow for graphical or other user defined reports, etc.

An example of a related DMS would be a rule-based compensation system provided by a consultant which would monitor employee salaries periodically and compare them to community standards (which would be provided on a periodic basis by the consultant), monitor compliance with pay equity guidelines, and if necessary suggest actions which should be taken by senior management to rectify problems.

At this point it is necessary to emphasize that it is not possible to completely differentiate among different types of Information Systems. These definitions will be used to define different approaches to supplying computer based support to decision makers. In the end, the adequacy of these definitions is determined by whether or not they represent most types of approaches for supplying decision support, and whether they are defined clearly enough so that they represent the same construct to different individuals. The test of this adequacy will be in whether or not these definitions are accepted by subjects in empirical studies supporting this research (as described in Chapter Four), and whether or not consistent results are obtained from these studies.

It is important to note that we have defined the OIS, DMCS and DMS in terms of their function rather than their structure. This is in accordance with general systems theory and with the reality of today's technology where the same tools can be used in different systems.

Just as Simon stressed looking at the overall decision making process in differentiating between programmed and nonprogrammed decisions, researchers working with DSS have suggested that DSS research needs to consider the support of the whole decision making process, not just isolated decision tasks (Nunamaker et al [1988]). If we look at the entire decision making process using task complexity as defined by Wood (1986), then OIS perform a small set of different tasks (although these may be highly repetitive so that the total number of tasks performed is large), and there is a relatively simple precedence relationship among these tasks. Furthermore, neither the set of tasks nor the relationships among the tasks tends to change over time. Therefore we could say that in some sense the OIS represents the automation of less complex decision making processes (and will form the basis for "less complex approaches").

DMS are designed to automate, and DMCS to automate or support more of the overall decision making process, and therefore perform (or are capable of performing) a larger set of tasks. The interrelationships between these tasks are often more complex (involving feedback loops between different tasks), and over time the number of tasks and the relationships among the tasks is subject to change. In some sense these systems represent the automation of more complex decision making processes (and will form the basis of "more complex approaches").

2.1.4 APPROACHES FOR SUPPLYING DECISION SUPPORT

We have defined an approach for supplying computer based decision support as having two components: the type of system supplied, and the level of end user participation in the systems development process. (The term participation is used in the sense of Barki and Hartwick [1989], that is participation refers to a set of behaviors or activities performed by individuals. The systems development process refers to the analysis, design, and implementation of an information system.) We will use the three generic system types defined in the previous section to implement the first component.

A large body of IS literature discussing systems development deals with the topic of end user participation in the development of various of these types of information systems. In the literature on DSS, there is nearly a consensus (Silver [1988] that systems designed to support decision makers should be developed in some sort of adaptive or evolutionary fashion with the end user. Some writers have stressed that this is critical. In articles describing some of the other types of support systems listed earlier, the participation of the user also appears important.

Based on the preceding discussion, we have defined our Participation construct in the following manner. If, in developing a support system with a decision maker, the development is evolutionary with the final end user, then we will assume that it requires a high level of end user participation and will be defined as a High Participation Approach. If the development is evolutionary, but involving someone other than the eventual end user then we will define it as a Low Participation Approach. If the development of the system is non-evolutionary and does not require a high level of end user participation we will also define it as a Low Participation Approach. Although we have not considered all non-evolutionary, participative approaches, we will consider non-evolutionary approaches that have mechanisms allowing a substantial amount of feedback from the end user in the analysis and design phases to be High Participation Approaches.

If we include a Null Approach we have a set of five development approaches in terms of these two constructs: participation in the systems development effort, and the level of complexity of the support system. These are defined in Table I and described in more detail in the following sections.

TABLE I

APPROACHES FOR SUPPLYING COMPUTER-BASED SUPPORT FOR DECISION MAKERS

1) The Null Approach is used for situations where no meaningful computer based support system could be implemented.

The two "less complex" approaches are:

2) The Prototyping Approach, a less complex approach which requires a high level of user participation in the development of the system.

3) The Systems Development Life Cycle Approach, a less complex approach which requires a low level of user participation in the development of the system.

The two "more complex" approaches are:

4) The Decision Maker Centred Approach, a more complex approach which requires a high level of end user participation in the development of the system.

5) The Decision Making Systems Approach, a more complex approach which requires little end user participation in the development of the system.

2.1.4.1 THE DEVELOPMENT PROCESS

Langefors [1977] suggested that the systems perspective has two main aspects: the construction aspect and the operations aspect. The construction aspect is concerned with how the system can be built up from individual components in such a way that the system as a whole can attain the desired external properties. Once operating, a system can be described in terms of its form (structure) and function (Churchman [1979]). Ginzberg and Ariav [1984] said that design proceeds from an ideal system to a critical review of resource availability for defining a feasible system. Based on Churchman [1979] they defined five systems aspects that must be considered:

(1) the environment (decision situations and access patterns)

(2) the role (types and levels of decision support)

(3) the components (i.e. dialog, data and model management)

(4) the arrangement of the components (i.e linkages among the components and the assignment of functions to modules)

(5) the resources available for the system (i.e. hardware, software human skills and data)

If a system is to meet a given need, (in our case to help decision makers make better decisions from an overall organizational perspective) then the development of the system must be undertaken in an appropriate fashion, so that the resulting system will have the desired properties. In this context an appropriate fashion was defined as one which takes into account the five systems aspects described above.

The role the system is expected to fill allows us to differentiate between different system types (and indirectly between approaches). Some systems are designed to replace human decision makers (DMS). Other systems, although they do provide some level of support for decision makers, will have as their primary function organizational transaction processing and report production (OIS).

In describing the environment we are in a sense defining the needs or what has to be done. As Silver [1988] noted it is part of the accepted wisdom in DSS research that different situations require different types of support. Therefore the situations will define the role that the system is to play.

Once the external factors have been determined (i.e. the environment, and how the system is to interact or impact on its environment) then the internal factors can be considered. The last three systems considerations: the components, their interrelationships and the available resources, tell us what the system is to look like. Ideally the systems design should initially consider the components necessary to fill the role, and how they should be arranged. Only then should reality in the form of resource constraints be considered. If we place the user in a central position in the decision making system (i.e. utilize him/her as a valuable system resource) then we can define which approach to take to develop the necessary system, based on the level of resource availability, including end user participation.

2.1.4.2 REVIEW OF OIS DEVELOPMENT ISSUES

Since their inception there have been complaints about computerized support systems. Part of the reason has to do with the nature of the demands on information systems. Galbraith [1976] stated that:

> "The greater the task uncertainty, the greater the amount of information that has to be processed among decision makers during task execution in order to achieve a given level of performance."

He then went on to suggest three methods for reducing this uncertainty:

(1) by means of Coordination by rules or programs
(2) by means of a Hierarchy where the more complex decisions are are referred to a level in the hierarchy where a global perspective exists
(3) by means of Coordination by targets or goals.

Information Systems were developed to help decision makers cope with an increasingly more complex environment. They can do this by helping an organization to cope with the increased information processing load that comes with the increased uncertainty that accompanies a more complex environment. If the information systems themselves contribute to the environmental complexity rather than helping to simplify the situation then they simply are not doing their job. There will be dissatisfaction with them.

Ackoff [1967] in a classic article, "Management Misinformation Systems", stated that simply supplying the manager with more information and more communications will not increase his effectiveness but may in fact decrease it. A manager (decision maker) needs more of the "right" or appropriate information, and less information in total. Similarly a manager has enough to worry about learning and maintaining expertise with the tools of his own profession without having to learn about the complexities of CBIS. To help remedy these problems Ackoff suggested a five stage development process for information systems. This would help systems people to develop better information systems without requiring managers to become systems specialists. He also suggested that three groups must participate in this process: the managers, the systems specialists and the analysts.

Many others have attempted to define how systems development should proceed. Peters [1981] reviewed different systems development life cycles, before defining a simplified life cycle with four stages: analysis, design, implementation and operations. Lucas [1986] stated that Computer Based Information Systems have a life cycle just like a living organism or a new product and lists ten stages consisting of several sub-stages. Ciborra et al [1980] presented a review of systems analysis methodologies and attempted to develop a framework with which to compare them. They stated that a causal link exists between the failure of many applications and the lack of a sound methodology to capture user information needs and to design a new system accordingly. Taggart and Tharp [1977] have attempted to evaluate various Systems Analysis approaches. Munro and Davis [1977] also compared methods for determining information requirements. Sprague and McNurlin [1986] outline some "New" approaches to IS development and Konsynski [1989] provides a review of the advances in IS design.

Although problems in developing Information Systems have been identified since the late 1960's, and many researchers have attempted to develop more appropriate development strategies, the problems have persisted until the 1980's. Several researchers have developed radically different methods of developing information systems (e.g. prototyping (Davis [1982], Burns and Dennis [1985], Gaines [1988]) or socio-technical systems development (Mumford and Weir [1979])) while attempting to solve these problems. These approaches involve high levels of user participation and are discussed later. Others have suggested the development of specialized breeds of IS such as Executive Information Systems (EIS) (McNurlin [1987]), Strategic Information Systems (Wiseman [1988]), Expert Support Systems (Luconi et al [1989]) and others.

2.1.4.3 THE FOUR APPROACHES

The Systems Development Life Cycle Approach

There are still many large scale information systems, such as the OIS described earlier in this section, that were developed using the systems development life cycle concept (SDLC) as outlined in Peters [1981]. In fact Necco, Gordon and Tsai [1987] state that the SDLC is still very widely used by most organizations for developing CBIS.

For the purpose of this paper a Systems Development Life Cycle Approach will be defined in terms of both the development approach and the function of the system it produces. The development approach includes analysis, design, implementation and operations phases for the development of the underlying system. Furthermore, although a methodology of this type may contain formative evaluation procedures to ensure that the project remains on track, it will not involve prototyping or evolutionary development (as these terms are normally interpreted). Also, although the development process may be participative, in that the user community as a whole will be represented, in general the individual decision makers will not design reports or support tools to help them with their specific decision making problems. That is, although the eventual end users could participate to varying degrees in the development of the system, the reports this approach provides to individual end users are from some set of standardized or easily created reports. From the perspective of providing computer based support to an individual decision maker this represents a low level of user participation.

As defined before, the system provides decision makers with information, as opposed to data and the means to analyze it. The focus of the system is managing the organization's information resources and providing support for structured problem solving. This approach can be defined as a Low Participation, Low Complexity approach.

The Prototyping Approach (PA)

As suggested in the previous section there are many authors who have suggested alternative design strategies for developing large scale information systems. In situations that can be classified as uncertain Davis and Olson [1985] and Burns and Dennis [1985]) have suggested that it would be preferable to develop systems in either an evolutionary fashion or by means of prototyping.

Keen [1980] suggests that all DSS need to be developed in an evolutionary fashion. Gaines [1988] suggests a prototyping approach for the development of expert systems. Other authors have suggested that in all systems development efforts, significant end user participation is necessary, and have described development approaches that are adaptive or evolutionary.

Cerveney, Garrity and Sanders [1986] present a model which describes three levels of prototyping: 1)Input/Output Design, 2) Heuristic Design and 3) Adaptive Design. They define Input/Output Design as the generation of printed reports and/or on-line screens. Heuristic Design is defined as the development of screen formats and some system functions. Adaptive design involves the complete development of the system in an iterative fashion (and is most suitable for the development of DSS).

We will define a Prototyping Approach in a fashion similar to Cerveney, Garrity and Sanders [1986] Input/Output or level 1) definition. The Prototyping Approach produces a support system which supplies information to a decision maker from an existing underlying OIS. The information is provided as a set of reports for a specific decision maker which are developed in the following fashion. The production of the initial report(s) is the first step in the development of the support system. There is some form of feedback mechanism whereby the user can request changes or improvements in the report(s) with which he is supplied. In the extreme case there is no final set of reports as such, but a set which is currently in use and which is in the process of evolving as new needs or present inadequacies are identified and changes implemented. We will define this approach as a High Participation, Low Complexity Approach.

2.1.4.3.1 APPROACHES BASED ON MORE COMPLEX SUPPORT SYSTEMS

" The concept of Decision Support has evolved from two main areas of research : the theoretical studies of organizational decision making done at Carnegie Institute of Technology during the late 1950's and early '60's and the technical work on interactive computer systems mainly carried out at the Massachusetts Institute of Technology in the 1960's." (From the series forward of the Addison Wesley series on Decision Support by P.G. Keen and C. Stable.)

The first DSS were designed to aid senior managers in making decisions involving semi-structured or unstructured problems. Early texts on DSS outlined the contributions of Management Science, MIS, Behavioral Science and Computer Science to this emerging field (Keen and Scott Morton [1978], Alter [1980]). The development of this concept of decision support as a separate class of information systems can be followed by examining how the various definitions have evolved since the early 1970's. To aid in understanding the development of the concept we have made use of a framework from Ginzberg and Stohr [1982] which separates the elements that characterize DSS into 3 groups:

(1) The underlying technological components (ANATOMY)

(2) The ways the DSS are used (PHYSIOLOGY)

(3) The processes by which DSS are developed (ONTOGENY)

One of the first frameworks for DSS was developed by Gorry and Scott Morton [1971]. It concentrated on the nature of the decisions being supported (semi-structured or unstructured), and on the organizational level being supported in order to determine what situations would be appropriate for the implementation of a DSS. This framework made use of Simon's taxonomy of decisions and a taxonomy developed by Anthony [1965] for specifying Organizational level. This reflected a concern with how the system was to be used, or the PHYSIOLOGICAL aspects of DSS.

Early definitions also indirectly addressed the issue of user involvement. These systems were directed at managers in the higher levels in the management structure, who were clearly discretionary users. It was considered important that the support systems not impose a foreign decision making structure on the user (Keen and Scott Morton [1978]). These systems focused on an individual user rather than a user group. (DeSanctis and Gallupe [1985], Nunamaker et al [1988])

Later definitions, developed following the implementation of several of these support systems, considered system objectives and usage patterns as essential features of a DSS (Alter [1980]). Alter concentrated on the PHYSIOLOGICAL aspects of these systems as had earlier writers. However, when he attempted to define different types of DSS as either model based or data based, he was emphasizing the ANATOMY of the support systems.

Alter's model defined seven types of systems and six generic operations that could be performed by support systems. These operations formed a hierarchy with the most sophisticated systems performing all the operations, including making the decisions. However, in general, users of these first DSS had a great deal of discretion in whether or not they made use of the systems.

Carlson [1983] was also interested in defining what types of problems (PHYSIOLOGY) were amenable to DSS type systems. He used the Simon model to help determine which operations in the organization appeared to be suitable grounds for DSS development.

Keen [1980] defined DSS in terms of how the system was developed. He claimed that it was necessary to take an evolutionary approach in order to develop adequate systems for decision support. This marked a transition in how the user was viewed with respect to the system. The user had always played a key role in the development of decision support systems. However, rather than tailoring a system to the user, the user now played a key role in the development of the system.

In terms of the model derived from Ginzberg and Stohr, Keen focused on ONTOGENICAL and PHYSIOLOGICAL aspects of the system. He allowed for both evolution in use as well as evolutionary development (prototyping, as suggested in his article on using value analysis for DSS justification (Keen [1981]), is an example of evolutionary development). Evolutionary usage is where there is no final system, but the system itself keeps growing and changing as the users needs continue to change, and the user learns more of its capabilities.

Moore and Chang [1983] suggested that it was not possible to define decision support systems in terms of what type of decisions they could support because that depended on the decision maker. Instead they focused on the how the system was used and what were its capabilities (PHYSIOLOGY).

Bonczek, Holsapple and Winston [1981] defined DSS in terms of three components: a language subsystem, a knowledge subsystem and a problem processing subsystem. They included the user as part of the system itself. This awareness of the role of the user as controller of the decision making process and of his importance in the development of this support represents the core of what we will define as the DMCS approach. Although technically they were concerned with the system's components, which would suggest an emphasis on the ANATOMY of the system, they were also concerned with the PHYSIOLOGY and ONTOGENY. They have redefined the role of the user from being outside of the system, boundaries, to being an integral part of the system itself. This allowed for the possibility of having a decision ratifier as the user, with the computer having taken over most of the actual decision making functions.

By including problem processing in the system Bonczek, Holsapple and Winston [1981] made it possible to define a range of DSS based on whether or not they make use of analytical models and procedural languages (in support of a decision maker), or non-procedural languages and heuristic search-based problem-solving techniques (in support of a decision ratifier).

Turban and Watkins [1986] carried this one step further. They quote Alter in suggesting that in the future DSS will disappear and be replaced by Expert Decision Support Systems (EDSS) which will be a blend of DSS and ES. Luconi et al [1989], Henderson [1987], Jones [1986], Goul and Tonge [1987] and others have discussed how to make use of the technology and concepts from work on ES in developing sophisticated systems to support rather than replace decision makers.

Sprague [1980] presented a framework classifying various roles in the use and development of DSS, and for defining how this support is provided. Sprague's definition considered ANATOMICAL, PHYSIOLOGICAL and ONTOGENICAL factors. First Sprague defined five roles associated with the support system process. Depending on the end user and the tools available, the end user could fill various sets of these roles, including those which contain the more technical responsibilities. He then defined five methods of integrating (or development and implementation). The user participation in the development of the system varies with each method of integration. Finally he defined three levels of support: specific DSS, DSS generator and DSS tools.

Later authors have described how to develop DSS to aid decision makers with ill-structured problems (Cats-Baril and Huber [1987]), for strategic decision making (Sabherwal and Van Grover [1989]) or for other specific types of decision making. These models focus on the PHYSIOLOGY or use of the support system.

Decision Maker Centred Approach

As with the term MIS there is no clear definition of DSS that would receive universal recognition. However, it appears that there are a considerable number of systems which could be defined as Decision Maker Centred Systems in the following manner :

They will have the following PHYSIOLOGICAL characteristics:

(1) they provide support for decision makers,

(2) they provide support for "unstructured or semi-structured environments",

They will have the following ANATOMICAL characteristics:

(3) they allow the user convenient access to the system resources (well developed user interface),

(4) they make use of the end user as a resource in their design, development, and operation.

The Decision Maker Centred Approach (DMCA) will be defined as a Decision Maker Centred System with the following ONTOGENICAL characteristics:

(5) the development will be participative, making use of the end user as a resource.

(6) the development will be evolutionary because both the requirements for the final system and the available resources will change as the user (or the user community) participates in the development process.

Therefore it can be defined as a High Participation, High Complexity approach.

Decision Making Systems Approach

Expert Systems evolved from research into Artificial Intelligence (AI) to form another "class" of support systems for decision makers. AI is itself a new field whose origins date back to the 1950's (Minsky [1984], Winston [1977]). An interesting history of AI can be found in the book "The History of Artificial Intelligence" by McCorduck [1979].

For our purposes there does exist an alternative approach to decision support which can be defined based on several different definitions of Expert Systems. The term "Expert System" itself carries strong connotations regarding just what the system is or what it can do (as did the terms MIS and DSS). Therefore it is impossible to provide a single clear definition for what an "Expert System" is. We have attempted to use the context free term Decision Making System (DMS) for which we have developed the more precise definition needed for research purposes.

The Decision Making Systems Approach (DMSA) can be defined in terms of the model of Ginzberg and Stohr as follows:

It will have the following PHYSIOLOGICAL Characteristics:

1) It will replace, not support a human decision maker.
2) It will be useful in semi-structured or unstructured decision making situations.

It will have the following ANATOMICAL characteristics:

3) Normally it will feature some type of heuristic problem solving module working in conjunction with a knowledge base.
4) The end user will not be part of the decision making system.

It will have the following ONTOGENICAL characteristics:

5) It will be developed in an evolutionary fashion.
6) The final end users will not be involved with the development of this type of support system, so it will not be participative.

Therefore it can be defined as a Low Participation, High Complexity approach.

2.2 THE INDEPENDENT VARIABLES : THE FACTORS AND THEIR ATTRIBUTES

In the previous section a set of approaches for supplying computer-based support to decision makers was outlined. In this section a framework or model to help in differentiating among situations will be outlined. Ginzberg and Stohr [1982] have developed a framework for comparing different models of decision support systems. This provided a useful tool for determining what constructs or attributes the various authors who have written about support systems have considered important. A second framework, based on general systems theory, was used to develop a small set of high level factors that could be used to differentiate between situations. Finally the attributes were associated with the factors. This provided the initial input into the Delphi process (See Appendix I for a description of a Delphi Process) which produced the final model.

The initial model which was submitted to the Delphi panel contained three factors, described by eighteen attributes. After the Delphi study, the model was structured into four factors which were described by twenty attributes. This is the model which was used to describe or define the various situations, and this is the model that will be described in detail here.

2.2.1 THE FOUR FACTOR MODEL

To be able to distinguish between situations it is proposed that situations can be adequately described by four factors, each of which is composed of various attributes. The general model is shown in Figure II while details of the factor values and attribute levels are in Table II and Table III respectively.

There are some important assumptions underlying the development of this model. The most important is that the factors and attributes underlying the model will be initially represented by simple discrete representations. Normally the best we could do would be to define attribute levels or factor values as being more or less appropriate or accurate descriptors of a given real world situation. However, by operationalizing the attributes and factors in terms of very broad categories, we can attempt to capture the real distinctions between situations rather than getting lost in the overlap of the concepts or the terminology.

TABLE II

FOUR FACTOR MODEL FOR SYSTEM SELECTION

Factor I: User Participation in the Decision Making Process

Values : High Level of User Participation
Intermediate Level of User Participation
Low Level of User Participation

Attributes: User Role in the Decision Making Process
User Participation/Solicitation in Systems Development
User Discretion (in System Use)
Problem Importance (to the Decision Maker)

Factor II: Problem Space Complexity

Values : Complex, Moderate, Simple

Attributes: Problem Uniqueness
Problem Set Complexity
Data Resource Complexity
Range of Problems (in the Problem Set)
Interdependence of Decisions
Problem Structure

Factor III: Resource Availability

Values : Null, Simple, No_Constraints,
Decision Making System Approach

Attributes: Availability of (Problem Domain Specific) Human Experts
Developer Task Comprehension
User Systems Development Comprehension
Availability of Technology(at Cost Beneficial Prices)
Availability of Time (To Develop Specific Systems)
Availability of Systems Personnel (to Develop Systems)

Factor IV: Organizational Context

Values : Supportive, Non Supportive

Attributes: Previous History of MIS Projects
Organizational Resistance to Change
Official Endorsement
Organizational Environment

Note: Phrases in () may be left out of attribute names, depending on the context.

Table III
LEVELS FOR THE ATTRIBUTES IN THE FOUR FACTOR MODEL

Factor I: User Participation in the Decision Making Process

ATTRIBUTE	LEVELS
-User Role in the Decision Making Process	Decision Maker, Decision Ratifying Role, True Decision Ratifier
-User Participation/Solicitation In Systems Development	Solicited-High Participation Solicited-Low Participation Unsolicited-High Participation Unsolicited-Low Participation
-User Discretion	Discretionary User, Forced User
-Problem Importance (to the Decision Maker)	Important, Unimportant

Factor II: Problem Space Complexity

ATTRIBUTE	LEVELS
-Problem Uniqueness	Unique, Recurrent
-Problem Set Complexity	Simple, Complex
-Data Resource Complexity	Simple (Data Resources) Complex (Data Resources)
-Range of Problems	Wide (Range of Problems) Narrow (Range of Problems)
-Interdependence of Decisions	(Pooled or Sequential), Reciprocal
-Problem Structure	Unstructured, Structured

Factor III: Resource Availability

ATTRIBUTE	LEVELS
-Availability of Human Expertise	Available, Unavailable
-Developer Task Comprehension	Experienced, Inexperienced
-User Systems Development Comprehension	Experienced, Inexperienced
-Availability of Technology	Available, Unavailable
-Availability of Time To Develop Specific Systems	No (Time) Constraints (Time) Constraints
-Availability of Systems Personnel	(Staff) Available Low (Staff) Availability

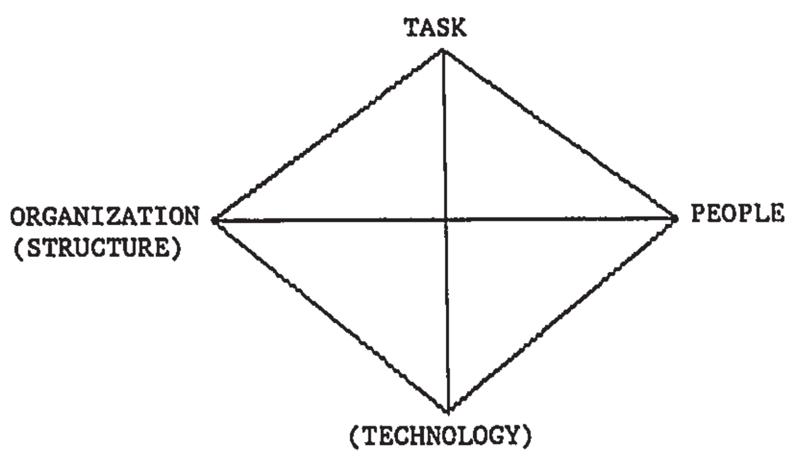
Factor IV: Organizational Context

ATTRIBUTE	LEVELS
-Previous History Of MIS Projects	Successful, Unsuccessful
-Organizational Resistance to Change	Resistance to Change Supportive of Change
-Official Endorsement	Official Endorsement Little Support
-Organizational Environment	Supportive, Non Supportive

Note: Depending on the context phrases in () may be left out of attribute names or attribute level names.

2.2.2 THE DEVELOPMENT OF THE OVERALL MODEL: THE FOUR FACTORS

The Leavitt diamond (Figure IV) is used to show the interrelationship between the different parts of an organization. It shows the interrelationships between the task, technology, people and the organizational structure (Taesik and Grudnitski [1985]). Many previous contingency models (Davis [1982], Culnan [1983], Courtney et al [1983], Mann and Watson [1984], Burns and Dennis [1985], Garanto and Watson [1985], Sethi and Teng [1988]) have used some of these factors.



THE LEAVITT DIAMOND

FIGURE IV

A Delphi Panel (see section 3.4 for a description of the Delphi Technique) was asked to validate the model. The initial model originally submitted to the Delphi panel omitted the organizational structure component. This initial model postulated that for determining which approach(es) would be appropriate for supporting a decision maker, many of the organizational structure variables could be taken into account as either aspects of the task (problem attributes) or the people (user attributes) or the technology (resource availability). However, the Delphi panel preferred to use all four factors.

The four factors can also be derived from Churchman's five basic considerations in the general definition of systems. We have defined approaches for developing computer-based support for decision makers as being composed of:

systems - the components and the arrangement of the components

implementation - how the systems are implemented.

We have also defined an overall role for these systems (to aid decision makers in making better decisions from an organizational perspective). If we are able to define situations (the resources that are available to develop the system and the environment the system will exist in), then we can match approaches to situations (which is our goal). Based on Ginzberg and Ariav [1984] the environmental considerations include characteristics of the problem or task type and access pattern (which includes characteristics of the user and the user's organization). Therefore we need to know about the resource availability, the characteristics of the problem, the characteristics of the user in the use of the system, and the overall organizational context (Table II and Table III show the four factors and their attributes.)

2.2.3 DEFINITIONS OF THE FACTORS AND THEIR ATTRIBUTES

2.2.3.1 FACTOR I: USER PARTICIPATION IN THE DECISION MAKING PROCESS

The first factor, User Participation in the Decision Making Process is operationalized as having three levels: Low Participation, Intermediate Participation and High Participation. We will make use of the definition of Barki and Hartwick [1989] of User Participation as a set of behaviors or activities performed by the users. It is assumed that users who perform more of the activities associated with the decision making process will need a different type of support system than those who perform fewer of the activities.

(1) USER ROLE IN THE DECISION MAKING PROCESS

Early definitions of DSS stressed their role in supporting rather than replacing decision makers (Alter [1980], Keen and Scott Morton [1978], Ginzberg and Stohr [1982]). Lee [1983] differentiated between ES which seek to replace the decision maker with a decision ratifier and DSS which support the decision maker. Henderson [1987] differentiates between ES which replace decision makers and DSS which support them, but suggests that in practice the distinctions are not this clear. Others have described how DSS and ES could be merged in Expert Support Systems (Turban and Watkins [1986], King [1986], Fordyce and Sullivan [1986], Luconi et al [1989]).

This attribute defines the role that the user chooses to adopt; i.e whether the user accepts the role of decision ratifier as opposed to the role of decision maker. Adler [1984] suggested that one of the major problems with commercializing medical diagnostic expert systems is that doctors (like most other professionals) will accept computer-based advisors, but not substitutes. This means that in general they insist on remaining part of the decision making process or on remaining decision makers, rather than becoming decision ratifiers. Therefore in selecting which approach to use it is necessary to understand which role the user wants to play.

This attribute has three levels; "Decision Maker", "True Decision Ratifier", and "Decision Ratifying Role". The third level was added when respondents to the second phase of the validation process (section 3.5.2) differentiated between decision ratifiers who change their role depending on other situational factors, and those who always function as true decision ratifiers.

(2) USER PARTICIPATION/SOLICITATION IN SYSTEMS DEVELOPMENT

This attribute refers to the user's activities during the systems development process, rather than the activities of the user in the decision making process the system is designed to support. There are two dimensions of this attribute: whether or not the user has solicited the system, and whether or not the user has a high need to participate in the systems development process.

The effect of solicitation of the system has been studied by several authors. Sprague and Carlsen [1982] suggested that a user who has solicited or initiated the systems development effort has a greater stake in the success of the system than one who has not. Similarly Courtney et al [1983] used Alter's [1980] results to show that DSS are more likely to be successful if they are solicited by either the user or top level management. They also argued that successful implementation is easier if the user has solicited the system. They apparently reasoned that a user who solicits a system will have enough of an understanding of the problem space to have identified the need for a system. We will operationalize this dimension of the attribute as Solicited or Unsolicited.

Many authors have discussed the effect of end-user participation during the systems development, on the systems success. Debrabander and Edstrom [1977] and Debrabander and Thiers [1984] suggested that the type of interaction between the user and the system developers can be related to system success. Silver [1988] asks what do we do substantively as we proceed to design DSS in an adaptive fashion with user participation. If the user is forced into sham participation then it may be worse than no participation at all. This is because in these situations a user may use the system as little as possible once it has been developed. Debrabander and Edstrom also suggested that effective communication will be defined differently in different situations. Similarly Oppelland and Kolf [1980] defined different types of appropriate user participation in different situations. Hirscheim [1985] has reviewed user experiences with participative design. We will use a simple dichotomous representation for this dimension of end user participation, High Participation, and Low Participation.

User participation in the widest sense includes participation in the choice of the tools, therefore we will hypothesize that this attribute can be operationalized as a four leveled variable with levels:

"Solicited - High Participation"

"Solicited - Low Participation"

"Unsolicited - High Participation"

"Unsolicited - Low Participation"

During the analysis of the results of the second phase of the validation study (section 4.2.1) we will test whether or not they can be considered as different dimensions of one underlying construct.

(3) USER DISCRETION IN SYSTEM USE

This attribute is closely related to user role. Whether or not users will accept or reject a given role depends on the amount of discretion they have. However, the amount of discretion that users have may affect which approach for supplying decision support should be selected. This is in addition to whether or not they will accept a role as a Decision Maker or a Decision Ratifier, which is defined by the attribute User Role.

If we consider the situation where the user is left in the role of decision maker the user may have considerable discretion over whether or not to use the system in a given situation. Methlie [1983] states that many users of DSS have considerable discretion over how and when they will perform a specific task and a choice of the tools that they will use. Young [1983] stated that the managerial user will retain control over the task and outcome and Lucas [1986] suggested that DSS users have more discretion than other system users. Hogue [1989] suggests more research has to be done on whether or not the user uses the output from a DSS at his/her discretion.

We will operationalize this concept as a dichotomous variable with values "Discretionary User" and "Forced User". A "Discretionary User" would be able to choose not only the type of support system, but the method used to solve the problem, the data needed, etc. A "Forced User" would have little choice.

(4) PROBLEM IMPORTANCE TO THE DECISION MAKER

User involvement (Barki and Hartwick [1989]), which has to do with the importance of the problem to decision makers, is related to user participation in two ways: (1) It may affect how the user will structure the decision making environment (thus influencing the type of support system the user will want or accept), (2) Depending upon the importance of the problem to the decision maker, he/she may take a more or less active role in the decision making process, thus more directly influencing the type of support system required. For this study, user involvement has been operationalized as Problem Importance.

This is one of the attributes suggested by the participants in the Delphi study. Some of the comments included when participants were asked for additional attributes were "Importance of the problem to the decision maker ", "Interest or willingness of the individuals", "Crises occurring". As well, one of the participants explained the difference between involvement and participation and suggested both were important issues. These all seem to have a common element of addressing the user perception of the problem as being important, in defining the user's participation in the decision making process.

The two levels are "Important" and "Unimportant".

2.2.3.2 FACTOR II... PROBLEM SPACE COMPLEXITY

This factor refers to the complexity of the task of developing the particular support system, from the systems development perspective. It is hypothesized that it will be more or less difficult to develop a support system based on the characteristics of the problem space with which the user is confronted. (By problem space we mean the set of possible problems or problem types that the decision maker may face over the expected life of the system). This factor is operationalized as Complex, Moderate or Simple.

(1) PROBLEM UNIQUENESS

There are two considerations here. The first is whether the problems are unique or ad hoc, or whether they are recurring. The second is whether they are unique to one user or are found organization-wide. Many authors have stated that ES are only appropriate in situations where problems are recurrent (e.g. R.Davis [1982], Turban and Watkins [1986]). This is similar to Institutional DSS (Donovan and Madnick [1976], Garanto and Watson [1985]) as compared to Ad Hoc DSS. If the computer system must be designed to take over more of the Decision Making process, then it will be more complex and/or more expensive to develop. This variable was operationalized in a dichotomous fashion for the next phase of the research with levels "Unique" and "Recurrent".

(2) PROBLEM SET COMPLEXITY

Sabherwal and Grover [1989] suggest that problem homogeneity or the degree of problem type variety affects the difficulty of providing support for strategic decision makers. Sanders and Courtney [1985] and Mann and Watson [1984] discuss some of the attributes of problem type variety and their affects on computer based support.

Turban and Watkins [1986] suggested that ES are more suitable for a narrow domain and DSS for a wider problem domain. This may be because ES performance in general "degrades rapidly" outside a narrow area of expertise (Davis [1984]). Donovan and Madnick [1976] in their comparison showed Ad Hoc DSS more appropriate for situations where there is a wider problem domain than Institutional DSS. From a systems development point of view, the need to handle more than one problem set would create a more complex problem space in that it would take a more sophisticated system to deal with this variety. For example, Efstathiou et al [1986] suggest that one shouldn't try to develop general purpose inference engines, so if one develops a large knowledge base then one will need to develop several different inference engines for multiple users to make use of this valuable resource. This is similar to developing multiple DSS utilizing the same data base, as opposed to developing one overall DSS. This variable is operationalized as "Complex" (when there are multiple disjoint problem sets), or "Simple".

(3) DATA RESOURCE COMPLEXITY

This attribute represents the complexity of data resources required by individual problems that the decision maker may face, so it is an attribute in the problem space factor rather than in the resources factor. A problem space requiring "simple data resources" is one where the data required by problems that the decision maker might face can be pre-specified or at least access to the data can be pre-specified in some sense. A problem space requiring "Complex Data Resources" is one where the data required to solve the problem (and the source of that data) cannot be specified a priori. This is based on the Donovan and Madnick [1976] comparison of Institutional and Ad Hoc DSS and the problems.

Nunamaker et al [1988] suggest that the need to access a wide range of ad hoc data, both internal and external, is necessary if unstructured decision processes are to be supported. It would appear that the greater the number of possible sources the more complex the problem of designing a system to access these sources, especially if there is no certainty over which sources should be used in any situation (this could be why in practice so few DSS address ill-structured problems as noted by Cats-Baril and Huber [1987] and Nunamaker et al [1988]). Watson and Sprague [1989] describe some of the difficulties in collecting and maintaining data from a wide variety of sources.

This attribute will be operationalized as either "Simple Data Resources", or "Complex Data Resources".

(4) RANGE OF PROBLEMS

This attribute differs from the problem set complexity (attribute 2 of this factor) in that even if a problem space can be said to encompass only one type of problem (one problem set) one may still be able to define a range of problems within that problem set (Donovan and Madnick [1976], Garanto and Watson [1985]). An example would be a financial support system that is required to provide support to a particular financial analyst. This system is designed to work with a particular type of problem, rather than a variety of problems (financial, manufacturing, personnel etc.) However, depending on the decision maker it may be required to provide support for a wider or narrower range of problems of that type. This is especially true in the case where the system is expected to grow and develop with the user. In many ways this attribute is related to the concept of evolution in use introduced by Keen [1980] in that, unless the support system can be "fully developed" initially, to provide support for the entire range of problems within a problem set it must be able to grow with the user. However, many proponents of evolutionary DSS argue this may be neither possible nor desirable. This variable will be operationalized as a dichotomous variable with values "Narrow Range of Problems" and "Wide Range of Problems".

(5) INTERDEPENDENCE OF DECISIONS

This attribute can be operationalized based on a three valued taxonomy of Thompson [1967], and used by many writers on DSS (e.g. Sprague and Carlson [1982]). Pooled refers to decisions which are basically independent. Sequential refers to systems in which decisions are made serially, with each decision based on the previous one in a linear fashion. Reciprocal refers to decision making processes where decisions from one decision maker affect those made by another, and in turn those decisions may affect the decisions made by the first decision maker, in a type of feedback process.

Basic systems theory (Davis and Olson [1985]) tells us that if we can break a system into a set of minimally interacting subsystems, designing and maintaining that set of smaller systems will be simpler than designing and maintaining the original single large system. The more interaction between decision makers (human or automated), the less independent the decision making subsystems are and the more complicated the task of designing support for them. Sprague and McNurlin [1986] suggest that Group DSS (GDSS) will be used to support pooled interdependent decisions. Based on a similar rational we will operationalize this variable as "Pooled or Sequential" (a state representing a low level of interaction between decision makers) and "Reciprocal" (a state representing a high level of interaction).

(6) PROBLEM STRUCTURE

This attribute is derived from the modification of the Simon [1960] taxonomy used by Keen and Scott Morton [1978] to describe the characteristics of problems that DSS should be focused on. It is assumed that it may be possible to specify at the time of system development some idea of the degree of structure the problems will possess. This is not to say that the problems cannot be broken down into structured and less structured segments, but that this cannot be done a priori. The concept that it is a more difficult task to support users in a less structured problem space is rooted in much of the DSS literature (Scott Morton [1971], Alter [1980]). Indeed Cats-Baril and Huber [1987] suggest that most DSS support Decision Makers dealing with moderate to well structured problems. Nunamaker et al [1988] suggest that little has been done to support decision makers facing less structured problems, possibly because of the difficulty or cost of doing so. The concept of task structure is also discussed in section 2.1.3.

This attribute is implemented as a dichotomous variable with levels "Structured" and "Unstructured".

2.2.3.3 FACTOR III...RESOURCE AVAILABILITY

The resource availability factor will be assigned four values representing points on a scale from no support possible (Null), through restricted support possible (Simple), to no restrictions on the support available (No Constraints), to the need for computer controlled decision making (DMSA).

Null-------------	Implies that it will not be possible to provide computerized support due to the lack of resources.
Simple System----	This means that the availability of resources will force the choice of more basic support systems.
No Constraints---	This means that resources will not constrain the choice of strategy as suggested by the other factors.
DMSA-------------	Implies that it will be necessary to supply a Decision Making System due to the lack of available, problem specific, human expertise.

(1) AVAILABILITY OF HUMAN EXPERTISE IN THE PROBLEM AREA

This attribute is meant to represent whether or not a capable human decision maker exists in a particular situation. If not then it will be necessary to supply a computerized decision maker. One of the arguments behind research to develop expert systems has been the scarcity of human expertise in certain fields and therefore the need to "clone" this expertise (Winston [1984]). It is operationalized as a dichotomous variable with values "Available" and "Unavailable".

(2) DEVELOPER TASK COMPREHENSION

The higher the level of knowledge of the developer for developing support systems for a particular problem space, the greater the probability that the system can be pre-specified (Davis [1982], Burns and Dennis [1985], Sethi and Teng [1988]). If the opposite is true then the system will most likely need to undergo some form of evolutionary development. This variable is operationalized in the following fashion:

"Experienced"------------- The developer has a good understanding of the problem space the user is facing either by having developed similar systems or by having knowledge of the user's task because of previous training.

"Inexperienced"----------- The developer has little understanding of the problem space faced by the user.

(3) USER SYSTEMS DEVELOPMENT COMPREHENSION

The higher the level of comprehension that the user has concerning the task of developing information systems, then the greater the probability that the systems analysis phase will produce a better product, or that any type of system pre-specification will be successful, and the system will more easily be made to fit the users needs (Davis [1982], Burns and Dennis [1985], Sethi and Teng [1988]). This is because a user with a knowledge of the systems development process is more likely to positively interact with the systems development team. This variable is operationalized in the following fashion:

"Experienced"-------------	The user has a good understanding of the use of support systems in this particular problem space either by having previously cooperated in a similar project or having had some formal training in Information Systems.
"Inexperienced"-----------	The user has little understanding of how a computer-based system might be useful, or of how it might be developed.

(4) AVAILABILITY OF TECHNOLOGY

This attribute is operationalized as appropriate technology being either "Available" or "Unavailable" at a cost beneficial price for a specific project. Note that although the appropriate software might exist it may be too expensive for use in a particular situation. For example, a framework package may exist that is suited for one particular application but it would require the purchase of specific hardware so that the total cost would be prohibitive. Or there may not be appropriate commercial software available for a particular application so that the system would need to be developed from lower level tools (Prolog, Lisp, a DBMS, a procedural language etc.) which would increase the cost and time required to develop the system.

(5) AVAILABILITY OF TIME TO DEVELOP SPECIFIC SYSTEMS

This attribute represents whether or not the time to develop a system is a major constraint. Donovan and Madnick [1976] suggest that Ad Hoc DSS (which leave more of the Problem Processing with the user) are more appropriate (or realizable) than Institutional DSS in situations where time is critical. Similarly, unless there are existing systems available, it would appear (Hayes-Roth et al [1983], Davis [1984]) that it takes a considerable amount of time to develop a DMS. Also Courtney et al [1983] suggested that if the time frame is short term normally some form of crash design would be used. Cats-Baril and Gustafson [1988] suggest that timeliness of data is one of the concerns in deciding whether to collect and analyze data on a routine basis, since a larger and more complex system is needed to continually monitor the environment (as opposed to providing information only when it is needed). Such a system would take more time to develop. Availability of time is operationalized as "No Time Constraints" and "Time Constraints".

(6) AVAILABILITY OF SYSTEMS PERSONNEL TO DEVELOP SPECIFIC SYSTEMS

This attribute measures whether or not there are sufficient support staff to provide aid to develop individual systems. It will be operationalized as "Development Staff Available" and "Low Staff Availability".

2.2.3.4 FACTOR IV: ORGANIZATIONAL CONTEXT

During the first phase of the validation process, several of the Delphi study respondents felt that it was necessary to take into account the organizational context in an explicit fashion. Examples of models where this is done (Leavitt Diamond) were given and individual attributes based on organizational context were also suggested. Mason and Mitroff's [1973] seminal paper "A Program for Research on Management Information systems" can be taken as the beginning of the accepted tradition of contextual approaches for analyzing information systems issues. Ein-Dor and Segev [1978] suggested that the successful development of information systems depended in part on their organizational context. They empirically studied the effects of four of the organizational context variables that they had suggested. Olson [1978] and Olson and Chervany [1980] studied the relationship between organizational characteristics and the structure of the information services function. In the late 1970's and early 1980's several other authors also studied the relationship between organizational variables and characteristics of IS (i.e. Sanders and Courtney [1985], Cerveny and Sanders [1986], Cheney, Mann and Amoroso [1986], Rivard [1987]).

In this section a reduced set of organizational context variables are outlined, because it is believed that many organizational factors affect the availability of resources, which is addressed in Factor III. This factor will be operationalized as "Supportive" or "Non-supportive".

(1) PREVIOUS HISTORY OF MIS PROJECTS

It is postulated that if the organization has a poor history of IS implementation, then the individuals in the organization will have less of a predisposition to work with computer systems. This corresponds roughly with the Ein-Dor and Segev factor of Psychological Climate (also mentioned by Cheney, Mann and Amoroso [1986]). Although the user may have worked with previous systems, personally know what can be done with computers, and may actually feel that they are beneficial, he/she may be alone in his/her beliefs and not actively support the development of a system, believing the risks if it fails are more significant than the rewards if it succeeds.

In this context we could say that if the organizational history was "Successful" then it will increase the probability that more sophisticated systems will be implemented as opposed to the case where the history was "Unsuccessful".

(2) ORGANIZATIONAL RESISTANCE TO CHANGE

This attribute can be interpreted in one of two ways. In fewer and fewer organizations there is a complete lack of experience with computer-based systems. In these organizations the implementation of computer-based systems would represent a major change. Since major changes may be stressful to the members of an organization, there would be a natural resistance to change in that organization. In other organizations, there can be a distinct traditional sense, where even though they make use of technology, they are reluctant to do so. A value is placed on doing things the way they have been done and it is more difficult to justify changing the status quo. This variable could be interpreted as having two states: "Resistance to Change", (so that it is more difficult to implement more sophisticated technology) and "Supportive of Change".

(3) OFFICIAL ENDORSEMENT

Many writers on organizational context suggest that an important factor affecting the success of implementation of an MIS is official organizational support. This can take many forms: the organizational position of the MIS executive is sufficiently high in the organization, or the steering committee is placed high enough in the organization (Ein-Dor and Segev [1978], Rivard [1987], Young [1989]) so that it can exert true pressure to make available the necessary resources for change, or the executives themselves are supportive of the use of computer-based support systems.

Official endorsement can have two effects, it can improve the organizational climate to make systems development more acceptable, or it can free up resources to make it more possible. It will be operationalized as "Official Endorsement" and "Little support".

(4) ORGANIZATIONAL ENVIRONMENT

Ein-Dor and Segev [1978] suggest that factors from both the organization's internal and external environment affect the implementation of IS in that organization. These factors could include the stability of the environment, the market share, the industrial markets in which the organization competes, and the internal stability (stability of management, stability of process technology). Duncan [1972] in an early article on organizational environments says that both the internal and external environment must be considered.

The postulate here is that organizations that face more uncertain environments will have more complex decision making tasks than those which face more stable environments (similar to comments by Galbraith [1976]), and in the more complex environments it will be more necessary to provide more sophisticated support systems because they will need not only better data, but better tools to manipulate and transform that data into information. It will be operationalized as having two states "Supportive" and "Non-Supportive".

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

In the first stage of this research a model was developed, based on a thorough search of the literature. The model and the literature it is based on have been outlined in the preceding chapter. In the next stage the model was validated using a three phase process. This chapter contains a discussion of some general issues in validation as they apply to this type of research and a description of how the experimental tests of this model's validity were carried out.

3.1 MODEL VALIDATION

The method of validation chosen for the proposed model used two similar, although theoretically different paradigms. The first experimental methodology, which can be used to argue the validity of the model, generally follows the outline of Straub [1986]. This is a more typical Information Systems (IS) approach to validation. The second makes use of the tenets of Social Judgment Theory (Hammond [1980]) which has been found useful in policy determination research.

Both discussions of model validation will be based on the data from two types of studies or tests of the model. One test of the model (which is referred to as the first phase of the validation process), involved submitting the model to an expert panel in a Delphi exercise (a detailed description of the Delphi process is found in Appendix I). The other test involved interviewing a number of subjects who have a knowledge of Information Systems issues, either by virtue of their being practitioners, (IS analysts, or IS managers, or executives) or by being academics working in the IS field. The interviewing process incorporated the second and third phases of the validation process. In the second phase a separate test of each factor and the relationship of that factor with its underlying attributes was conducted. In the third phase, sets of factor values were matched to system types.

3.2 VALIDATION: USING THE METHODOLOGY DESCRIBED BY STRAUB

Campbell and Stanley [1966] have described two types of validity: internal and external validity. Internal validity can be described in terms of causality, (does A cause B?) whereas external validity is defined in terms of how well (if at all) the results of a particular study can be generalized from the experimental situation to other situations. Unfortunately, as Campbell and Stanley observed, we can only speak of approximate validity since we can never prove validity, only disprove it.

Cook and Campbell [1979] defined internal validity in terms of statistical conclusion validity and construct validity, and external validity in terms of being able to generalize results to target populations and across target populations.

Straub [1986] defined a model for conducting IS research so as to ensure approximate validity. He defined three types of validity:

1) Instrument Validation (consisting of three phases: Content Validity, Construct Validity and Reliability)

2) Internal Validity

3) Statistical Conclusion Validity

For the purpose of our research Statistical Conclusion Validity can be treated as a part of Internal Validity as Cook and Campbell [1979] have suggested, and indeed it is the only issue of Internal Validity that concerns this particular research. Instrument Validation and Internal Validity are discussed in the following sections.

3.2.1 INSTRUMENT VALIDATION

3.2.1.1 CONTENT VALIDITY

An instrument possesses content validity if it is representative of the real universe, rather than the author's view of the universe. To ensure content validity one can submit the instrument to a form of expert review (Cronbach [1971]). Three possible methods of expert review were considered for this study : the use of a questionnaire, the Nominal Group Technique (NGT) and the Delphi Technique.

The simplest method of expert review would have been to submit the model in the form of a questionnaire to a number of experts. If a closed questionnaire (Davis [1982]) were used one would have to ensure that all possible attributes and factors were listed initially and associated with the correct factor. If an open questionnaire (Davis [1982]) were used it would be difficult to ensure that attributes that represented the same construct were removed, and there was a high possibility of the model becoming very large with a large number of related factors and attributes, many of which overlapped or were of importance to only a few individuals. In either case it would be difficult to allow the experts to change the model structure (e.g. move an attribute from one factor to another).

The other two methods, which involve obtaining expert consensus, are the Delphi Technique and the Nominal Group Technique (Hampton et al [1987], Gibson et al [1979], Dietz [1987]). The NGT is a highly structured face-to-face decision making process. It is effective in developing group consensus. However, because it involves getting the expert panel together in one location for a long meeting, it was considered impractical for this particular research effort. The method of obtaining expert consensus which was selected for use in the first phase of the validation process was the Delphi Technique (Linstone and Turoff [1975], Irvine and Martin [1984]). The Delphi is a normative group technique which employs an expert panel who are individually given the instrument and asked to comment on it. The individual responses are then collated, and a summary of the responses is sent back to the respondents. This process is repeated until a consensus has been reached.

3.2.1.2 CONSTRUCT VALIDITY

Construct validity is an operational issue. It asks whether the measures chosen are true constructs describing the event or artifacts of the methodology itself. One of the major threats to construct validity (Cook and Campbell [1979]) involves inadequate pre-operational explication of constructs. This means that the constructs used must be as clearly and unambiguously defined as possible.

Because of the feedback mechanism involved in a Delphi study, this problem is less serious in this type of a study than in questionnaire-based research. However, if the constructs are presented in a format that is difficult for the Delphi panel to comprehend, then the process of gaining consensus will be hindered and many of the comments submitted by the respondents may be requests for clarification of the constructs. In the extreme, participants may give up in frustration.

In case-based research this means: (1) that the dependent variable must be clearly defined for the subjects, (2) that the independent variables should be clearly defined, and (3) that the cases themselves should be pretested to ensure that they do represent the situations that they are supposed to.

Two other threats to construct validity are the possibility of having mono-operational bias or mono-method bias. The former refers to a biasing based on having only one exemplar of a construct. For example,if we were interested in the effect of communications expertise on retention then we should have multiple communicators, with as different characteristics as possible so that any extraneous factors might be identified as affecting the retention. The latter refers to using a single methodology to test the constructs, ignoring the effects that the testing procedure itself may have on the results (Cook and Campbell [1979]).

Note that in most types of behavioral research there is usually a trade off between the levels of the various validities that the researcher is able to ensure (Judd and Kenney [1982]), and often it is not possible to fully demonstrate all the different types of validity, so that some judgment must be used in deciding which validities present real threats to the model. This holds true for Information Systems research in general, as well as for this research in particular.

3.2.1.3 RELIABILITY

Reliability is defined as the degree of consistency between two measures of the same thing (Mehrens and Lehmann [1984]). There are four common methods that can be used to estimate reliability; test-retest, parallel forms, split-half and internal consistency (Ferguson [1976]). None of these is particularly appropriate in our situation.

The test-retest method allows one to generalize how an individual would do if presented the same task at different times. This method assumes that if the individual performs the task similarly in both cases then the test is reliable. Problems include learning occurring between test and retest, memory effects, and the need to administer the same test twice. This method is not appropriate for IS research involving senior managers because of the probability of high subject mortality (drop-out) rates, and the "learning effects" that would most certainly be present with as difficult a cognitive task as this.

One method of implementing a test-retest type of strategy is to use equivalent or parallel forms, so that the individual is presented with two tests composed of different, but equivalent questions. This means that one can eliminate the memory effects and lessen the amount of learning between tests if the two tests can be scheduled close together.

The practical problem of using this method in survey research is the high probability that the respondents will drop out between tests.

If the parallel forms method is taken to the extreme, one develops the split-half estimate of reliability. Here the two tests are given simultaneously, with each test forming "one half" of the administered test. The underlying assumption here is that the two halves of the test are equivalent. The problem here is often the length of the instrument, since one effectively has twice as many questions.

An approach that measures the internal consistency of an instrument would appear to be the most practical in many forms of IS research. If a model is being tested in a range of situations the reliability of the model can be tested by analyzing the internal variation of responses on an individual basis as well as analyzing aggregate performance (Cronbach [1951]).

In general we can say that the two sources of unreliability are: vagueness in the test questions, and the possibility of the subjects not understanding the task (inter-subject and intra-subject variability (Stanley [1971])). If the subjects do not understand the task then they will tend to answer in a random fashion. Thus the coefficient of multiple determination (R^2) for individual subjects will indicate whether or not lack of reliability is a threat to the validity of the study, since any increased randomness in the answers will lead to a reduction in the value of R^2. This however assumes that the model is linear or can at least be approximated by a linear model. If the model is not linear, than some other method (possibly residual examination) must be used to determine if there is a consistent subject policy. An important assumption is that there is no bias in the instrument itself that will lead to a trend being observed in the data.

In a study such as the one outlined here, one is concerned more with the consistency of the responses than with the reliability of the instrument per se. This is because it is assumed that expert decision makers will possess a consistent policy with regard to working in their area of expertise; otherwise their performance should be noticeably lower than others working in the field. Problems with the reliability of the instrument will tend to lower the measured consistency of the responses (see Cook and Campbell [1979] or Stanley [1971] for a discussion of reliability). Therefore we will assume that if the elicited policies are consistent for individuals, then the instruments are reliable.

3.2.1.4 INTERNAL VALIDITY

3.2.1.4.1 STATISTICAL CONCLUSION VALIDITY

Statistical Conclusion Validity is a measure of the mathematical relationships among variables. To improve this measure we must take care to:

(1) ensure that we use the proper statistical tools to analyze the results (that is, we do not violate some of the basic assumptions of the tests)

(2) not attempt any "fishing expeditions", (that is we need to recognize that if we look at the correlation between some variable X, and 100 other variables, at the .05 level of significance, then we will find a few "significant" correlations by chance, so we must consider the statistical effect of having made several comparisons).

(3) use reliable measures (as defined in the previous section).

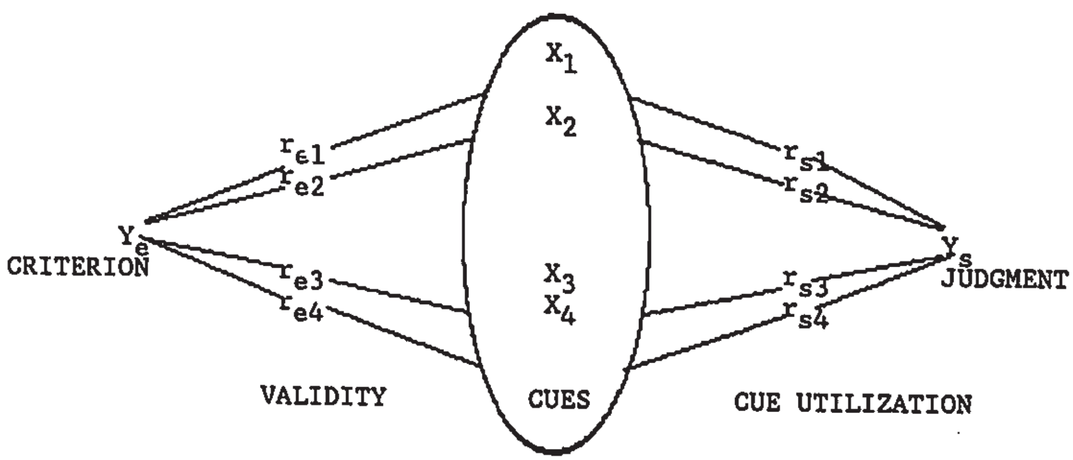
One of our concerns is to show not only that the model is valid for the situations that will be tested, but that it is valid for most situations that will occur. In theory we could test more and more plausible situations, making any interpolations of the results more and more accurate. In order to minimize the number of situations that need to be tested, so that we can reduce the resources required by such a study we can:

(1) select representative situations which in some way span the total set of situations,

(2) test them in a fashion which could logically be expanded to include the entire set, if the resources were available.

3.3 ANOTHER APPROACH: SOCIAL JUDGMENT THEORY

Social Judgment Theory makes use of the Lens model of Egon Brunswik (Hammond et al [1986], Hammond [1980], Doherty [1980]) to describe how judgments involve interactions between the environment and subjects. The model is based on representative design and the use of idiographic-statistical analyses for the description of the judgment policy of each individual subject. (Idiographic-statistical means that significance tests should be applied to each subject's behavior.) The lens model (Figure V) displays how there are two parallel sets of relationships: between the environment and the cues used to model the environment, and the judgments based on models utilizing the cues. Just as the individual may have different utilization rates for each cue (r_{si}'s), so the cues vary in ecological validity (r_{ei}'s); being more or less representative of the real environment.



THE LENS MODEL
FIGURE V

In examples presented in Hammond et al [1964] and Hursch et al [1964], the distal variable or criterion was the actual IQ score of a group of 78 patients. The cues were the patients' responses or scores on 19 Rorschach factors. The judgments were the estimates of a group of clinicians as to the patients' IQ scores. Multiple regression was used to determine the environmental validities, (the multiple regression coefficients of determination which are represented by r_{ei}^2). These values correspond to the relationship between the cues or the factors used in making judgments and the value of the criteria in the "real" world. The relation between the subjects and the cues, (the values of r_{si}^2), represent the clinicians' ability to make use of a particular cue. Note that the study is idiographic-statistical because it is based on the idea of uniqueness of each person's judgments. Each person must be considered as an individual, and each individual's behavior must meet statistical tests of regularity or dependability before the behavioral data can be defined in terms of situational variables.

Hammond et al [1986] suggested that a general quantitative study based on the lens model proceed in four stages. Doherty [1980] describes the methodology in relation to definition of Judgment Policies in more detail, outlining a six step process. The first four steps are used in defining the model, the last two steps in defining the use of the model. The first four are:

1) Find out what cues are potentially relevant to the determination of the distal variable.
2) Apply object sampling, to create a set of profiles or cases which represent or span the object space.
3) Define and obtain a set of policy implementers to make the judgments (subject sampling).
4) Capture the judgments of the subjects.

In the literature, (Hammond et al [1964], Cooksey et al [1986],[1987], Doherty [1980], York, Doherty and Kamouri [1987] are good examples) cue determination involved such activities as initial literature searches, deliberations with experts, and surveys of potential subjects. This insured that the set of cues was comprehensive yet manageable and could explain the majority of the policy variations.

Since the cases or profiles were to be as realistic as possible, the set of profiles or cases were often constructed from real cases to which the experimenter had access, with minor modifications made to mask identities. The key to this second step appeared to be ensuring that the cases represented adequately the universe to be measured. In some of the studies, this meant developing a set of cases which represented all combinations of all the levels of the independent variables or cues. In other studies this meant ensuring that a large set of cases (large with respect to the universe of possible real cases) was developed, and that the sample was statistically similar to the population as a whole.

The set of policy implementers was normally taken as individuals who would be faced with these types of decisions, although some studies made use of experts and some novices while others compared groups with different skill levels. In the Doherty studies where judgment policies were considered, care was taken to ensure that the subjects were representative of the population of policy implementers. Finally the judgment policies were examined. It appears that in the studies care was taken to ensure that the individuals had a stable judgment policy, and this was reflected by a high value of R_s (the multiple correlation coefficient).

If we compare the Doherty methodology to the validation methodology proposed by Straub, we see that many similar issues are considered by both. It is necessary to ensure that all relevant factors are included in the model, (this is done with the aid of experts). The entire judgment space must be adequately covered, and the implementers or subjects must be representative of the population that they represent. Also, it is necessary that subjects' responses be consistent to ensure that not only have they understood the task, but they are capable of handling it.

In our study we used experts in the Delphi panel to ensure that all relevant factors and their defining attributes are considered. We attempted to test all non-dominated situations using simplified two-valued or three-valued implementations of the factors and their defining attributes, ensuring adequate coverage of the judgment space. Finally, we selected three sets of respondents for the two final phases of the study who were knowledgeable about the task and who were representative of the total population of knowledgeable respondents.

3.4 THE METHODOLOGY OF THE DELPHI STUDY (PHASE ONE)

A description of the general Delphi technique can be found in Appendix I. In this section issues of particular concern to this study, which constituted the first phase in the validation of the model, will be discussed.

In setting up a Delphi it is critical that the expert panel consist of true experts, since we are relying on their expertise to validate the content of the model. For our purposes experts were defined as academics who had published in the leading MIS journals on related (i.e. "organizational aspects of MIS") topics. A list of suitable candidates was agreed upon, and members of the list were contacted by telephone to solicit their participation. Originally about sixteen individuals agreed to participate in the study. For reasons described later only ten members completed the first round and membership dropped to nine for the final rounds.

The expert panel were sent a questionnaire outlining the factors and the attributes which define these factors, descriptions of the approaches to supplying support systems, as well as the instrument itself (see Appendix II for the initial Delphi instrument, and the one used in successive rounds). They were initially asked to perform two tasks. The first was to define the structure of the model, having been given a three factor model as initial input. The second was to help assess how the model could be implemented, again having been given an initial proposed implementation.

To perform the first task the respondents were asked to answer on a Likert-like scale their impressions of the importance of each factor in defining different situations where different types of support systems could be used. They were also encouraged to list any additional factors that they felt were necessary to help describe situations. They were then asked to rate how well each attribute described the factor that it was associated with, using a Likert-like scale. They were also given the option of moving attributes between factors if they felt that they described another factor better than the one with which they were currently associated.

The second task that the respondents were asked to perform was to aid in defining how the model was to be implemented. A set of rules was proposed which indicated the effect that various factors would have on the types of systems to choose in different situations. The experts were asked to agree/disagree using a Likert-like scale and to again submit any comments, changes or new rules.

After all the experts submitted their initial responses these were analyzed and tabulated and returned to the panel. This continued until a consensus had been reached. The definition of consensus used in this study can be found in Table IV.

TABLE IV

RULES FOR DETERMINING CONSENSUS IN THE DELPHI STUDY

(1) Any component in the model (either factor or attribute) that was perceived as being very necessary or very important (a score of 5 on the 5 point Likert Scale) by at least two members of the panel would be kept in the model.

(2) Any component in the model that was perceived as being necessary or important (score of 4 on the 5 point Likert scale)by at least 2/3 of the panel would remain in the model.

(3) Any component with an average score of at least 4 would be kept in the model.

(4) Any component with at least 2/3 of the panel rating it as 3 or lower would be dropped from the model.

Note: In cases of conflict between the rules, the rules are listed in order of precedence, i.e. rule one would take precedence over rule four.

In order to reduce the possibility of experimenter bias, the questionnaire was designed so that little or no interpretation of the results was necessary, except for the tabulation of responses after each round. The questionnaire had either yes\no or numerical responses and a predetermined definition of consensus. (However respondents were encouraged to write in any comments that they felt were important.) This helped to ensure that the Delphi study could be capped after the minimum number of rounds. Based on the literature (Dietz [1987] and Erffmeyer et al. [1986]) the target number of rounds was three.

3.5 THE INTERVIEW METHODOLOGY IN THE SECOND AND THIRD PHASES

Phase Two of the research study involved associating attribute levels with factor values, and Phase Three built on this by associating factor values with systems development approaches. From the start of this research effort it was realized that it would be folly to attempt to work with a set of fifteen to twenty attributes describing different situations to be examined. If each attribute were represented as a dichotomous variable there would be 2^{20} or about one million different situations to consider in some fashion. Even if we could eliminate classes of situations as being either non-interesting or dominated in some sense by other classes it appeared that there would be far too many cases to consider.

The four factor model represents an hierarchical problem, which can be solved more simply (Keeney and Raiffa [1976]). The problem can be considered as two sub-problems, the first of which involves determining what attribute sets contributed to which factor values (for each of the four factors), and then the overall problem of which set of factor values could be associated with which systems development approaches.

Since each of the four factors has at most six attributes, there are less than 2^6 possible situations for each factor or less than 256 situations for the subproblem of associating sets of attribute levels with factor values. If each factor had three values, then there would be 3^4 or 81 situations for the subproblem of associating factor values with approaches. This represents a total of less than 400 situations for both subproblems combined, making the second and third phases of the validation process feasible.

3.5.1 PHASE TWO: VALIDATION OF THE FOUR FACTORS

After we had developed a set of cues and validated that set in some fashion, if we make use of Social Judgment Theory, the next step would be to develop a set of cases or profiles which could be presented to an appropriate group of subjects. Care must be taken to ensure that all relevant cases or profiles are somehow considered. If the variables are nominal in nature, one must consider presenting all possible cases. However, if the variables are ordinal, then one could make use of the inherent ordering of values and attempt to present a subset of the set of all possible cases. As long as the extreme points are included one could attempt to generalize to cases which are defined by intermediate values of the variables by making use of various dominance arguments. Care must also be taken to ensure that the subjects are representative of the population to which one would like to generalize the results of the study.

If we consider the model validation approach as defined by Straub [1986] to eliminate mono-method bias in the content validation of the model, one needs to make use of another method of content validation as well as the Delphi. One also needs to demonstrate construct validity; i.e. one needs to be able to show that the results will be applicable in many situations, which means that the responses of many subjects to the different situations are similar.

To provide a second measure of the content validity of the model and to provide a measure of the construct validity we presented a representative set of subjects various situations (defined by the levels of the attributes which make up the factors) and asked the subjects to determine the values of the different factors associated with each of these situations. We then attempted to determine if the set of attributes determined by the Delphi to describe each factor was complete and correct.

To help ensure that the proper subjects were used, the four factors were divided into two sets of two, Factor I and IV being organizational in nature, Factor II and III being technical in nature. In an attempt to ensure proper subject sampling, subjects who were given the sets of cases for Factor I and IV held managerial or administrative positions. Subjects given the cases for Factor II and III held senior IS positions. Approximately 25 interviews were conducted for each factor, with each subject receiving both cases for the factors in their set (This took about 90 minutes of the subject's time). The interviews were conducted in Hamilton, Ottawa and Kingston, and an effort was made to include as much demographical variability as possible (see section 3.3). This included interviewing subjects from the public and private sectors, from bureaucratic organizations such as the military, and organic ones such as universities, as well as using both male and female respondents. We have chosen a technique used in Multi Attribute Value Theory (or Multi Attribute Utility Theory) research to elicit subject response to many different situations without the need to present totally different profiles or cases to the subject or the need to provide standard gambles (Torrance [1976], Torrance et al. [1982]).

The first step was to develop a set of four instruments which would adequately represent as many of the different situations (sets of attribute values) as possible. For Factor I, with four attributes having (2,2,2,4) possible levels respectively, there were 32 possible situations. Factor III had attributes with (2,2,2,2,2) possible levels for a total of 32 possible situations. Factor IV had attributes with (2,2,2,2) possible levels for a total of sixteen possible situations. For these three factors it was determined that the best technique would be to present all possible situations to the subjects.

Factor II presented a different problem. There are six attributes used to describe Factor II, each having two assigned levels. There would need to be a total of 64 situations presented to the subject to completely cover all possible combinations. Since this was thought to be too large a task to give to the subjects, the number of situations was reduced by use of dominance arguments. Initially it was postulated that we could reduce the number of situations from the initial 64 to 23 by the use of two hypotheses, as follows:

1) Consider Factor II to be composed of two sets of three attributes, each of which could be considered independently (one set being composed of Problem Uniqueness, Problem Set Complexity and Data Resource Complexity, the other of Problem Structure, Range of Problems, and Interdependence of Decisions).

It was assumed (based on the literature search, as well as the comments received during the Delphi) that the attributes, Data Resource Complexity and Problem Set Complexity, were each dominant in defining the factor value. That is, if either of these attributes was defined as being at the level which contributed to increased Problem Space Complexity, (their "high" value) then the Factor value would be automatically set at Complex. It was also believed that Problem Uniqueness might be dominant as well, but this was not as certain.

2) It was assumed that the remaining three attributes had a less drastic effect on Problem Space Complexity, in that one could not assume that setting any one (or even setting all) of them to their "high" level would cause the factor value to be set to Complex.

Based on these two hypotheses for Factor II it was decided to:

(1) Test all eight combinations of the first block of attributes (those that were assumed to be dominant) when the other three attributes were set to their "low" value). This would establish whether or not the attributes were indeed dominant.

(2) Use the situation where all attributes were set to their "high" value as a benchmark.

(3) Test the remaining seven combinations of Problem Uniqueness set to its "high" value while keeping Data Resource Complexity and Problem Set Complexity at their "low" values, with the other set of three attributes. This was necessary in case Problem Uniqueness was not dominant.

(4) Test the remaining seven combinations of the second set of attributes against the situation when all of the first set of attributes were set to their "low" value.

Having decided on how to ensure that the appropriate environment was being sampled adequately, the next step was to ensure that the cases were clear enough so that the responses of the individuals really did correspond to their beliefs about what should be done in the various situations. As was previously mentioned there were several sources of ambiguity that could lower the credibility of the study.

I) The subjects might not understand what the various attributes or factors were.

To ensure that the subjects understood the various constructs in use in the experiment they were provided with written definitions of the factor and the various factor levels, as well as the attributes and the various attribute levels. They were then given additional verbal descriptions of these entities, since repetition helps learning, and since some individuals respond better to verbal instructions as opposed to written instructions (and vice versa).

II) The cases or profiles might not adequately represent the situations that they were supposed to.

To guard against this possibility the cases were first pretested by a panel of academics and practitioners to judge whether or not they represented the situations (set of attribute levels). The judges were given the descriptions of the factors and their defining attributes, the initial cases and subsequent modifications, and a set of cards with the attribute levels that the case (or situation) was supposed to match. If the judges felt that the situation did not adequately represent the set of attribute levels on the appropriate card they were asked to give reasons. Any situations that had been found to be problematic were then modified before the next judge was given the case. Four or five judges were asked to rate each case. For all cases, by the time the fourth judge was queried, that judge agreed that the situations, as described by the cases, matched the sets of attributes defined on the cards. This completed the pretest process.

During the interviews, to ensure that subjects would understand the situation being considered, they were given both a description of the situation (case) and a card listing the levels of the attributes.

III) The cognitive difficulty of the task might lead to inconsistencies in the responses.

A key assumption in Social Judgment Theory is that the underlying policies of the various subjects is more or less consistent. Therefore some degree of anchoring and adjustment in the subjects' cognitive processes is acceptable, provided that the cases are given in some logical order, which moves gradually between similar situations. Therefore we felt comfortable using a methodology similar to the one previously described by Torrance [1976], Torrance et al. [1982] for Multiple Attribute Value Theory studies.

In Phase Two, subjects were presented with situations which represented the different combinations of attribute levels and asked to give their preferences for describing the various situations in terms of each of the given factor values. For example, for Factor I they would be given a situation and asked to state their preference for describing the situation as one where they would prefer to have a decision making style that could be described as incorporating a High level of Participation in the Decision Making Process, a Low level of Participation, or an Intermediate level. Factors I, II and III had three factor values to consider. The procedure was similar for Factor IV except that there are only two factor values.

Initially a type of preference thermometer (see Torrance [1982]) was prepared and the subjects were asked to display their preference for each factor value for each case individually on the preference thermometer. The cards which described the attribute levels, with which the subjects had been provided, were pointed at one end so they could be placed to indicate a particular level on the preference thermometer.

This technique had several problems associated with it. The first was that it simply was confusing to place more than 12 pointers on the thermometer at any one time. The second problem was that many of the subjects found it awkward or silly to use the thermometer at all. They preferred to give their responses as an ordered triplet e.g. (High 30, Intermediate 40, Low 70). Therefore this revised technique was adopted for this study. Since respondents from the beginning of the first set of interviews had not been making significant use of the preference thermometer as an aid, not using it at all was not believed to have significantly altered the task presented to the subjects.

Although it would have been preferable to have obtained the three responses per case as independent observations, this proved not to be feasible. The judgment policies of the subjects allowed for tradeoffs between the various levels as the situations changed. Because of the interrelations among the responses, subjects were allowed to give preferences between 0 and 100 for each factor level. They were told that a higher number indicated a stronger preference than a lower number, and that the results would be normalized during data analysis.

To enable the subjects to compare their responses from one case to another and to help them to express consistent policies the following steps were taken:

1) The subjects were seated so that they always had the matrix of responses in front of them so that they could see what their previous responses had been.

2) If a subject gave an inconsistent response, he or she was asked about the response. The purpose of this was not to enforce consistency, but to note why their policies changed drastically for small situational changes. The interviewer attempted not to correct the subjects but to query them to understand the differences in their responses. Sometimes these questions resulted in a change of answer, if the response was "wrong" from the subject's perspective, i.e. if they had reversed the direction of change from the previous result. Sometimes it resulted in a correction because, as they stated, their standards or baselines had indeed shifted and they wanted to reconsider their initial responses. Sometimes it resulted in an explanation of their policy. This was helpful in interpreting the results of the study.

3) The cases were presented so that there were a minimum number of cues changing value from one case to the next, helping the respondents to keep a common baseline. For example if there were four attributes (labeled A to D), each with two values, then all four combinations of two of the attributes (A and B) would be presented to the subject with the other two attributes (C and D) held fixed. Then C would be set to its other value and the four parallel cases would be presented. Then D would be assigned its other value and the parallel set of eight cases (with D at the new value) would be presented.

The last major concern about the validity of the technique had to do with whether or not the technique itself could introduce any regularity or pattern to the results, which would cause a systematic bias. To minimize the systematic effects of the method, cases were presented to different subjects in one of several orders. To minimize the biasing effects, the dependent variable (factor value) was presented in an asymmetrical fashion although by the end of the trial the subjects usually responded to each situation with a set of responses for all the relevant dependent variables. The analysis of the data from Phase Two is found in section 4.2 and a copy of the instrument is in Appendix IV.

3.5.2 PHASE THREE: VALIDATION OF THE SITUATION-APPROACH MATCHING

The methodology of the Third Phase was similar to that employed in the Second Phase, with some important exceptions. Because the task the subjects were now asked to perform involved selecting which of a set of systems development approaches they would choose in a given situation, it was felt that the target subject population had shifted to IS managers and academics. Subjects had to either have some understanding of IS theory to appreciate which system should be used in which situation, or they had to have had some managerial experience in the IS field to appreciate the consequences of their decisions. Prospective participants were told what the task was and asked if they felt that they had had appropriate experience. When individuals stated that they felt that they weren't appropriate subjects, they were asked to supply the name of an individual in their organization who might be more appropriate. Because of the difficulty in obtaining senior managerial subjects, the interviews were held in Toronto as well as Ottawa, Kingston and Hamilton. Altogether there were 24 subjects interviewed for this phase. There were fewer women interviewed in the third phase because there are few women in senior management positions.

Just as the cases in Phase Two spanned the Attribute Spaces, the cases in Phase Three spanned the Factor Space. There are three levels of Factor I (User Participation in the Decision Making Process), three levels of Factor II (Problem Space Complexity), four levels of Factor III (Resource Availability) and two levels of Factor IV (Organizational Context). This would mean that a brute force approach would require 3*3*4*2 or 72 cases. However, we reduced the number of cases necessary for Factor III as follows:

Factor III has 4 levels: Null, Simple, No Constraints, and DMSA. Null means that the resources are so constrained that it is not possible to supply a support system for the decision maker. In this instance, Factor III determines uniquely the systems development approach, which is the Null Approach. Similarly if the resource that is lacking is Human Expertise in the problem area, it had been agreed by the subjects in Phase Two that the best that could be done was to use a Decision Making Systems Approach. That is, if there was no human decision maker to support, then if you could do anything it was to create a Decision Making System, so that again the value of Factor III uniquely determined the type of approach, which is DMSA. This meant that we only had to consider the other two values of Factor III (Simple and No_Constraints), and consider (3*3*2*2) or 36 cases in all.

The last significant difference between Phase Three and Phase Two had to do with the validation of the cases. In Phase Two, draft cases were presented to a panel of experts who determined if they did represent the attribute sets that they were supposed to. Because of the hierarchical nature of the model it would have been more difficult for a panel of experts to validate the set of cases used in Phase Three. However the initial cases used in Phase Two had been constructed in a modular fashion. Also they had been deliberately designed in similar settings to make it possible to make up combined cases where the overall situation was described in terms of the text descriptions that had been determined in Phase Two to represent the various factor values. This ensured that the cases presented to the panel did indeed represent the specified set of factor values.

The supporting documentation that the subjects were presented with included a set of definitions of the various systems development approaches, a set of factor definitions including lists of the attributes which defined each factor, and a description of the task itself. The definitions were presented orally and in written form. The data collection procedure was similar to that employed in Phase Two. The data analysis from Phase Three is given in section 4.3 and a copy of the instrument is in Appendix V.

CHAPTER FOUR

ANALYSIS OF VALIDATION STUDIES

4.0 INTRODUCTION

This chapter discusses the validation of the four factor model. The First Phase of the validation process consisted of a Delphi study with a panel of academic experts to assess the content validity of the proposed model. The Second and Third Phases involved examination of the judgment policies of a set of practitioners and academics. This was done to complete construct validation and to gather implementation data. The interviews conducted in the Second Phase provided insight into the relationships between the four factors and their underlying attributes. The Third Phase interviews provided insight into how the factors combined to determine which approaches for developing support systems were preferred in which situations (as defined by the factor values).

4.1 ANALYSIS OF THE DELPHI STUDY

The purpose of the Delphi study was twofold. The first task was to produce a model that:

1) contained all of the factors that experts in IS would recognize as being important in determining which systems development approach should be used in different situations,
2) contained the necessary attributes to describe as fully as possible each of the factors.

The second task was to develop a model implementation strategy or a set of rules for selecting which of a set of systems development approaches should be used in different situations. For the purpose of this research, situations are defined in terms of unique sets of independent variable values.

4.1.1 THE FIRST ROUND

After the first round of the Delphi study two things became apparent. The first was that the overall list of attributes, or cues that might influence the selection of a systems development approach, was reasonably complete (see Table V for the numerical responses to the first round. A list of comments from the panel members is in Appendix III). The second was that the panel felt that the three factor model presented in the first round should be modified to a four factor model.

The addition of the fourth factor was not entirely unexpected. In defining three factors (User Participation in the Decision Making Process, Problem Space Complexity, and Resource Availability) an attempt

TABLE V
SUMMARY OF THE RESPONSES TO THE FIRST ROUND

ATTRIBUTE	AVG. RESPONSE	COMMENT
FACTOR I USER INVOLVEMENT IN THE DECISION MAKING PROCESS	4.5	Changed to user participation
(1) Need for a Decision Maker or a Decision Ratifier	4.4	
(2) Need for User Participation in the Systems Development	4.2	
(3) User Cognitive Style	2.6	Dropped from model
(4) Degree of User Discretion	4.2	
(5) User Decision Making Style	3.4	
(6) Organizational Decision Making Style	4.2	Moved to Organizational Context Factor
Average	3.8	
FACTOR II PROBLEM SPACE COMPLEXITY	4.8	
(1) Problem Uniqueness	4.3	
(2) Problem Set Definition	3.8	
(3) Data Resource Specification	4.0	
(4) Range of Problems	4.0	
(5) Problem Type	3.4	Dropped from model
(6) Interdependence of Decisions	4.3	
(7) Problem Structure	4.1	
Average	4.0	
FACTOR III RESOURCE AVAILABILITY	4.5	
(1) Availability of Human Expertise	4.5	
(2) User/Developer Task Comprehension	4.3	Split into two attributes.
(3) Availability of Technology	4.5	
(4) Availability of Time to Develop Specific Systems	4.4	
(5) Availability of Systems Personnel to Develop Specific Systems	4.4	
Average	4.4	

Notes: The responses were scored on a 5 point scale, with 1 representing unnecessary and 5 necessary. Responses marked between the demarcations on the scale were recorded to the nearest .5.

had been made to define factors which were as independent as possible, to make the analysis in the later phases of the project simpler. Therefore, although there was justification in the literature for an Organizational Context Factor (Chapter Two, Model Development, has a more detailed discussion of the theoretical basis of the model) it was felt that this factor would be significantly correlated with both User Participation and with Resource Availability. However, after the first round of the Delphi it became apparent that the expert panel felt more comfortable with a model that described the world in terms of all four factors, so the Organizational Context Factor was included in the subsequent rounds.

The model was significantly changed after the first round:

1) two attributes were dropped from the model entirely,
2) a compound attribute was split into two distinct attributes,
3) an attribute was moved from Factor I to the new factor,
4) five new attributes describing the new factor were created.

Of the 23 attributes listed in the second round of the Delphi, only sixteen were the same as in the first round.

Although consensus concerning the content of the model appeared to be forming, it was obvious that the task of developing a model implementation strategy was nearly impossible. Of the approximately fifteen respondents who had been sent the original instrument, only ten answered, and one of these answered only those questions concerning the model structure, and not those questions concerning the model implementation. The respondents were nearly unanimous in feeling that the second part of the task was extremely difficult, and more importantly several felt that it was not a useful exercise.

Based on these criticisms, it was decided that the validation of model implementation should not be part of the Delphi exercise. The development of an implementation strategy was delayed until the second and third phases of the validation process. In the second and third rounds of the Delphi study the panel were asked to consider only the structure of the model. There were no further defections from the panel after the first round.

4.1.2 THE SECOND AND THIRD ROUNDS

Once the fourth factor had been added to the model there were no other major corrections to the model structure. During the second round Organizational Culture, one of the new attributes suggested by the panel for the Organizational Context factor, was dropped from the model. An overall consensus was forming about what the factors and their attributes should be (Table VI). The third and final round of the Delphi produced the agreed-upon convergence, where the rules on

TABLE VI
SUMMARY OF THE RESPONSES TO THE LAST TWO ROUNDS

ATTRIBUTE	AVG. RESPONSE SECOND ROUND	AVG. RESPONSE THIRD ROUND
FACTOR I USER PARTICIPATION IN THE DECISION MAKING PROCESS	4.4	4.7
(1) Need for a Decision Maker or a Decision Ratifier	4.0	4.4
(2) Need for User Participation in the Systems Development	4.3	4.0
(3) Degree of User Discretion	3.7	4.3
(4) User Decision Making Style	3.3	3.1 (D)
(5) Importance of Problem to D/M	4.1	3.94 (6)
Average	3.9	(3.95) 4.16
FACTOR II PROBLEM SPACE COMPLEXITY	4.4	4.6
(1) Problem Uniqueness	4.5	4.1
(2) Problem Set Definition	3.6	3.9 (2)
(3) Data Resource Specification	3.8	3.9 (6)
(4) Range of Problems	3.7	4.3
(5) Interdependence of Decisions	3.7	4.1
(6) Problem Structure	4.7	4.6
Average	4.0	4.15
FACTOR III RESOURCE AVAILABILITY	4.5	4.7
(1) Availability of Human Expertise	4.5	4.6
(2) User Task Comprehension	3.8	4.8
Developer Task Comprehension	4.1	4.5
(3) Availability of Technology	4.3	3.94 (6)
(4) Availability of Time to Develop Specific Systems	4.6	4.7
(5) Availability of Systems Personnel to Develop Specific Systems	4.2	4.5
Average	4.3	4.5
FACTOR IV ORGANIZATIONAL CONTEXT	4.3	4.6
(1) Organizational History	4.4	4.5
(2) Organizational Resistance to Change	4.1	4.4
(3) Official Endorsement of Project	3.7	4.3
(4) Organizational Environment	3.7	3.9 (6)
(5) Organizational Culture	2.7(D)	
(6) Organizational Decision Making Style	3.6	3.4 (D)
Average	3.7	(4.1) 4.3

Notes: (A) The responses were scored in the same manner as round one. (B) For round three the averages shown in brackets are the averages for the attributes used in both rounds. The other averages represent the averages for attributes left in the model
(C): (2) kept because two people scored this a 5; (6) kept because 6 people scored this a 4 or higher, (D) to be dropped after this round.

attribute acceptance that had been set out before the study started were satisfied (Table IV in Chapter Three). The participants also rated Factor Independence in round three.

Two attributes (Organizational Decision Making Style and User Decision Making Style) were dropped from the model after the third round, leaving a total of 20 attributes defining four factors. The responses to the questions on independence confirmed the original expectations in that the lowest levels of orthogonality between factors predicted by the Delphi panel were between the Organizational Context factor (Factor IV) and both Factor I and Factor III. Using similar rules to those which were used to determine which attributes were included in the model (noting that a higher score means the two factors are more independent), these are the only Factors that were not independent.

TABLE VII
SCORES ON ORTHOGONALITY QUESTIONS

(1)	FACTOR I AND FACTOR II	3.94	(A)
(2)	FACTOR I AND FACTOR III	4.2	
(3)	FACTOR I AND FACTOR IV	3.2	
(4)	FACTOR II AND FACTOR III	3.6	(A)
(5)	FACTOR II AND FACTOR IV	4.1	
(6)	FACTOR III AND FACTOR IV	3.2	

Notes: (A) Two respondents scored this a 5.

4.2 ANALYSIS OF THE SECOND PHASE OF THE VALIDATION PROCESS

In the second phase, the objective was:

> To determine by means of rank order statistics if a unique factor value could be associated with each set of attribute levels, and if so to determine what that value should be.

In order to do this we would need to determine by means of regression analysis:

- if the attribute lists developed during the Delphi study were adequate for determining factor values(indicating if the respondents had consistent judgment policies)
- which of the attributes were significant in determining factor values (indicating if the model was adequate)
- the relative importance of each attribute to determining factor value (giving us insight into the model structure)

When performing the regression analysis, it was noted that for all factors, individual respondents were more consistent (had higher values of R^2), than the overall group when the factor values were regressed against the attributes or cues. It is plausible that the difference between the overall group consistency and the average individual consistency is caused by demographic differences in the subjects (e. g. a great deal of interest is currently focused on the differences in managerial styles of males and females). Similarly it would not be inconceivable that individuals in different organizational settings would have adopted different ways of interpreting cues or inputs, consistent with their organizational norms (Hampton et al [1987] discusses organizational culture). When this was discussed with respondents, most felt that despite the structured nature of the case approach, they brought their own biases into the process, based on who they were, and what they had done.

The presence of individual differences was expected, given the nature of the model. Although all factors and attributes were entered into the model based on the consensus of the expert panel, this did not mean that all experts felt that all of the attributes were important, or felt as strongly about each attribute. In fact some attributes that some experts felt were important were left out of the model(helping to explain why the average individual value of R^2 is high, but not extremely high for all factors). It was expected that subjects might use subsets of the attribute sets in their judgment policies.

Unique Factor values were assigned to each situation using Kendall's Coefficient of Concordance (W) for Factor I, Factor II and Factor III, where the number of factor values was > 2. For Factor IV, which has only two factor values, the Wilcoxon Matched Pairs test (which is used to distinguish between two related conditions (Seigel [1956])) was used.

Kendall's W is a measure of the degree of agreement of the rankings assigned by multiple judges. A value of W = 1 means perfect agreement, one of 0 means perfect disagreement. In using this measure one can assume that if W is significant then the ordering is significant and the level with the "best" ranking (lowest mean ranking) will be assumed to be the factor value associated with this situation. (This assumption is defended in Kendall [1948] and repeated in Seigel [1956] and Churchill [1983] as well as other texts). The mean rankings for each situation are obtained by summing the ranks assigned to each factor value over all judges, and dividing by the number of judges. For example, if there are three judges and they each assign a rank of one to a particular factor level, the mean rank = 1 (which is the lowest possible or "best" mean ranking).

Similar decision rules were adopted for all four factors.

For Factor II and Factor III the decision rule is:

IF Kendall's W is significant at the .10 level
THEN Factor value equals the factor value with the "lowest" ranking
ELSE No Factor value can be assigned

For Factor I the decision rule is:

IF Kendall's W is significant at the .10 level
THEN Factor value equals the factor value with the "lowest" ranking
ELSE Factor Value is Intermediate

For Factor IV

IF Wilcoxon Matched Pairs test is significant at .10 level
THEN Factor value equals the factor value indicated
ELSE No Factor value can be assigned

To determine the significance of W, the Chi-Square approximation can only be used if the number of items (N) to be rated is larger than 7. For N < 7 and M (the number of raters) < 20 tabulated values of S are available,(Kendall [1948], Seigel [1956]) for testing against .10

and .05 levels of significance. S, which is the sum of the squares of the deviations between the actual rankings and the theoretical rankings of perfect agreement, can be related to W with or without corrections for ties. Without the correction for ties

$$W = 12S/(M^2(N^3 - N) = S/S_m$$

With the correction for ties (T') this becomes

$$W = S/(S_m - M\,T')$$

and $T' = (t^3 - t)/12$ where t is the number of tied rankings and the summation is done over all sets of ties for all rankings.

In our case the most appropriate test of the significance of W was an approximation based on the Fisher z statistic, (tabulated in Fisher and Yates [1948]) as suggested by Kendall, rather than the Chi-Square test or an attempt to extrapolate from tabulated significance levels. This approximation is given by:

$$z = .5\ln((M-1)W)/(1-W))$$

Where z has parameters

$$v_1 = N - 1 - (2/M)$$

and

$$v_2 = (M-1)v_1$$

To determine the significance of the Wilcoxon Matched pairs test, the standard normal deviate (for which significance levels are found tabulated in most elementary statistics texts) was calculated from the sum of the ranks (T) by assuming that T is normally distributed. For the number of observations as small as eight, this is a good approximation (Seigel [1956]).

4.2.1 ANALYSIS OF FACTOR I

TABLE VIII
FACTOR I: USER PARTICIPATION IN THE DECISION MAKING PROCESS

VALUES
High Level of User Participation in the Decision Making Process
Intermediate Level of User Participation in the Decision Making Process
Low Level of User Participation in the Decision Making Process

Name	Attribute
Role	(User Role in The Decision Making Process)
Part	(User Participation/Solicitation in System Development)
Disc	(User Discretion in System Use)
Imp	(Problem Importance (to the Decision Maker))

Attribute	Levels
Role	Decision Maker, Decision Ratifying Role, True Decision Ratifier (DM, DR, TDR)
Part	Solicited-High Participation, Solicited-Low Participation Unsolicited-High Part, Unsolicited-Low Part (SH,SL,UH,UL)
Disc	Forced User, Discretionary User (F,D)
Imp	Important, Unimportant (I,U)

4.2.1.1 THE DEPENDENT VARIABLES FOR FACTOR I

The respondents were asked to put themselves in the position of the described decision maker, for each case, and to state their preference for using a decision making style that could be described as either High Participation of the User in the Decision Making Process, or Low Participation, or Intermediate Participation. (Alternatively, if they had trouble visualizing themselves as the decision maker they were asked which style they believed the decision maker described in the text would prefer to adopt.) They were asked to state this preference for each approach on a scale of 0 - 100, 0 meaning no preference for using this particular approach to decision making, and 100 meaning that they had as strong a preference as possible for using this approach to decision making. Subject responses to the three variables are the dependent variables and were named ValueH, ValueI and ValueL. A copy of the complete instrument is in Appendix IV.

Because they felt that these questions were related, many people answered the three questions as a set. They lowered or raised the two extreme values unless there was only a modest change in their perception of the situation, and only then would they change the middle value. When regression analysis was performed on the data, linear relationships were found between the indicator variables representing the attribute levels and ValueH and ValueL, but not with ValueI.

The Intermediate level really corresponds to an indeterminate state. Based on respondents' comments, often if the individual was not certain if he/she preferred a High or Low level in the situation, the preference for the Intermediate level rose. At other times if the change between two situations was slight the respondent increased the preference for the Intermediate level rather than increasing the preference for one of the extreme levels.

Because many respondents had been using this factor value as an indeterminate state it was decided to assign this factor value to those situations where no clear preference arose for either High or Low levels of participation. Further evidence that subjects used this factor value as an indeterminate state is found in the relatively small value of R^2 for individuals (about .38 for ValueI compared to about .76 for ValueL and .80 for ValueH). This indicates that while the subjects had relatively consistent policies for determining whether or not a situation was best described as High or Low Participation, they had no consistent policy for the Intermediate state. Also, of the 23 respondents, four had no attributes enter in the multiple regression equation for ValueI at the .10 level of significance. Another seven had Role as the only attribute to enter the regression equation at the .10 level, leaving only 12 with more than one attribute significant in determining preference for this factor. This would be the case if the Intermediate state was preferred, when the other states were not appropriate (i.e. if it were a true indeterminate state).

In section 4.2.1.5 it will be shown that the three dependent variables are measures of one related construct and can be represented by a single variable (VALUE) which defines the level of participation in the decision making process preferred in a given situation. VALUE is defined on [0 - 100] with 0 representing no user participation and 100 representing high user participation. The range of VALUE could be partitioned into three segments, each associated with a factor value.

4.2.1.2 SPECIAL CONSIDERATIONS FOR ATTRIBUTE PART

The attribute " User Participation/Solicitation in the Systems Development Process" could be included in the analysis in three different ways. It was initially felt, that although there were two bi-valued components to this attribute, they would act in conjunction, so that there would effectively be only three levels for this attribute, with SL and UH representing the same level. However, by treating these two components as two separate attributes during the interview we allowed for the converse to be true . Therefore we could do one of three things:

1) consider both solicitation and participation as independent attributes,
2) consider them as a single attribute with three values,
3) consider them as one four-valued attribute (using a system of dummy variables in the regression analysis).

To do this, two different types of regression analysis were run. First, three dummy variables were coded as shown in Table IX.

TABLE IX
CODING FOR ATTRIBUTE PART IN FACTOR I

Part Level	Part	Part3	Part4
SH	1	0	0
SL	0	0	1
UH	0	1	0
UL	-1	-1	-1

As well as reducing bias by using this scheme, the variable "Part" is the same as if we had recoded the 4 leveled attribute into an unbiased three level representation (the regression results are in Table X). The second set of regressions (Table XI) were run with the attributes Part1 and Part2 respectively standing for "Participation in the Systems Development Process" and "Solicitation of the System". They were then treated as independent variables in the regression equation, with each having levels (0,1).

When the regressions were run using Part1 and Part2, both entered the regression Equation, with significance at the .01 level for dependent variable ValueH. However for the dependent variable ValueL Part2 is significant at the .10 level. In doing this the value of R^2 is very close to the value when only Part enters into the equation.

The value of F is lowered noticeably for both ValueH and ValueL because two variables are being used to describe what can adequately be described by one. Therefore, the variable Part will be used to represent the attribute User Participation/Solicitation in System Development, with values of (1) when the system is both solicited and the user participated in its development, (0) when either the user solicited the system and did not participate in its development or when the user participated in the development of the system but had not solicited the system and (-1) when the user neither solicited the system nor participated in its development.

TABLE X

OVERALL REGRESSION RESULTS FOR VALUEH AND VALUEL IN FACTOR I USING PART, PART3 AND PART4

Function	ValueH		ValueL	
Multiple R	.74595		.72437	
Multiple R^2	.55644		.52471	
Adj R^2	.55396		.52205	
F	224.2		197.3	
Sig (F)	.0000		.0000	
Attributes entered	T	Sig T	T	Sig T
Role	22.23	.0000	-22.24	.0000
Imp	19.14	.0000	-16.28	.0000
Part	5.33	.0000	- 4.39	.0000
Disc	2.87	.0043	- 3.25	.0012
Const	8.86	.0000	47.48	.0000
Not entered				
Part3	.38	.7056	- .35	.7244
Part4	- .44	.6637	.77	.4410

Note that the regression results shown are for the aggregate population. Similar results were obtained for individual members.

Table XI

OVERALL REGRESSION RESULTS FOR VALUEH AND VALUEL IN FACTOR I USING PART1 AND PART2

Function	ValueH		ValueL	
Multiple R	.74616		.72480	
Multiple R^2	.55675		.52534	
Adj R^2	.55364		.52202	
F	179.4		158.0	
Sig (F)	.0000		.0000	
Attributes entered	T	Sig T	T	Sig T
Role	22.20	.0000	-22.28	.0000
Imp	19.13	.0000	-16.28	.0000
Part1	4.26	.0000	- 3.79	.0002
Part2	3.27	.0011	- 2.41	.0159
Disc	2.87	.0043	- 3.25	.0012
Const	4.18	.0000	41.37	.0000

4.2.1.3 ANALYSIS OF INDIVIDUAL RESPONSES

Regression analysis on the individual responses determines the consistency of judgments of the individual respondents. Only if individuals exhibit consistent response patterns can we define what factor value corresponds to which set of attribute levels. If individuals do not exhibit consistent judgment policies then we cannot assume that their responses are reliable. Although in some studies using Social Judgment Theory values of $R_s^2 >= .9$ have been reported, other studies report values considerably lower than this (Hoffman et al [1968], Doherty [1980],Hammond et al [1964], Hursch et al [1964], Brehmer [1986] Cooksey et al [1986]). Based on these articles and a discussion with R. Hackett [1989], mean values of R^2 of at least .72 (R = .85) will be taken to mean that the judges have exhibited linear consistency in their policies. Table XII is a summary of some of the significant results for regressions for Factor I using ValueH and ValueL as the dependent variable.

Some interesting trends are apparent in Table XII. It was observed that most respondents provided answers as ordered triplets, often changing the value of ValueH, then adjusting the value of ValueL, based on the change made to ValueH, and then changing ValueI.

The mean value and the distributions (Table XIII) of R^2 for ValueH and R^2 for ValueL are similar enough to suggest that there is a relation between ValueL and ValueH. Also, for 15/23 of the respondents all attributes that were significant in the regression equation for ValueH were significant for ValueL, and for another six only one of the four attributes changed with respect to whether or not it was significant at a given level.

More direct evidence of the relation between the dependent variables came from a further study where ValueH was regressed on ValueI and ValueL. When ValueH was regressed on ValueL the correlation coefficient (R) was greater than 0.9 for 17 of the 23 respondents, and for only one respondent was it less then 0.8. When ValueH was regressed on both ValueI and ValueL, R was greater than .95 for 14/23 respondents and less than .85 for only 2/23 respondents, with an overall average value of 0.95.

From the data in Table XII the average value of R^2 for the 23 respondents can be calculated (mean $R^2(H) = .795$, mean $R^2(L) = .76$). These values are much higher then the values of R^2 for the group as a whole ($R^2(H) = .56$, $R^2(L) = .525$). Also, consistency of each individual judge is higher than the consistency of the group overall (with one exception, see Table XIII). It is believed that the difference between the overall results and the mean of the individual results is due to the individual differences among respondents.

Table XII

INDIVIDUAL REGRESSION RESULTS FOR FACTOR I

Respondent	R^2(H)	R^2(L)	Attributes not Sig. at .05 level
Subject1	.76646	.49611	Part not sig at .10
Subject2	.98101	.97530	Part sig at .10
Subject3	.74741	.73955	Disc not sig at .10
Subject4	.82024	.82024	all significant at .05 level (I)
Subject5	.98638	.97022	(H)all significant at .05 level (L)Disc not sig at .10
Subject6	.84488	.63098	(H)Part sig at .10,Disc not sig at .10 (L)Disc not sig at .10
Subject7	.80786	.77234	Disc not sig at .10
Subject8	.63601	.60415	Part not sig at .10
Subject9	.80008	.80008	Disc sig at .10,Part not sig at .10
Subject10	.70970	.64341	(H)Disc not sig at .10 (L)Disc, Part sig at .10
Subject11	.92383	.98437	(H)Disc,not sig at .10 (L)Import not sig,Disc,Part sig at .10
Subject12	.79894	.66218	Disc not sig at .10
Subject13	.83448	.83394	Disc not sig at .10
Subject14	.72151	.63680	(H)Disc sig at .10,Part not sig at .10 (L)Disc,Part not sig at .10
Subject15	.71324	.88844	(H)Disc, Part not sig at .10 (L)Disc, Part not sig,Import sig at .1
Subject16	.99129	.98454	Disc, Part not sig at .10
Subject17	.62808	.59897	Disc not sig at .10
Subject18	.71476	.69083	(H)Part not sig at .10 (L)Disc sig at .10,Part not sig at .10
Subject19	.77310	.76081	Disc sig at .10,Part not sig at .10
Subject20	.87236	.85717	Disc not sig at .10
Subject21	.76445	.65209	(H)Disc not sig at .10 (L)Disc,Part not sig at .10
Subject22	.60786	.67610	Disc not sig at .10
Subject23	.83396	.83356	Disc,Part not sig at .10

Notes : All attributes are significant at the .05 level unless otherwise noted in the final column

(H) Attributes not significant at the .05 level for the ValueH analysis.

(L) Attributes not significant at the .05 level for the ValueL analysis.

(I) : Subject4 felt that the value of ValueH and ValueI would automatically go to zero if the role switched from Decision Maker to Decision Ratifier. Rather than entering these 16 records, which would make regression analysis on the other variables more difficult, only the sixteen records where the value of Role was set to "Decision Maker" were entered into the database. In general the difficulty with Role was handled by most respondents by adding a third level, where they presumed the individual would be attempting to take on the role of decision ratifier, but being human might not be as successful in some situations as in others. If the individual were a True Decision Ratifier then they agreed with Subject4 that ValueH and ValueI would be zero.

TABLE XIII

DISTRIBUTION OF R^2 FOR INDIVIDUAL RESPONDENTS FOR FACTOR I

Value of R^2	Number of Respondents ValueH	Number of Respondents ValueL
<.55	0	1
.55 -.60	0	1
.60 -.65	3	4
.65 -.75	5	5
.75 -.85	10	6
>.85	5	6

For all 23 respondents, the attribute Role was significant and for 22 of the respondents the attribute Problem Importance was significant. For 14 of the respondents the attribute Part was significant, but for only 6 of the respondents the attribute Disc was significant, (yet in the overall regression it was significant). This provides further validation of the model structure since on average the subjects in this phase of the research found all the attributes to be significant in their judgment policies. These results indicate that of the four attributes, Problem Importance to the Decision Maker and User Role in the Decision Making Process are dominant attributes and User Participation/Solicitation in System Development and User Discretion play a minor role in defining User Participation in the Decision Making Process (Table XIV).

Table XIV

VALUES OF R^2 FOR INDIVIDUAL ATTRIBUTES FOR FACTOR I

Attribute	R^2(H)	R^2(L)	T(H)	Sig T(H)	T(L)	Sig T(L)
Role	.30652	.32872	22.23	.0000	-22.24	.0000
Import	.22722	.17615	19.14	.0000	-16.28	.0000
Part	.01760	.01281	5.33	.0000	- 4.39	.0000
Disc	.00510	.00702	2.89	.0043	- 3.25	.0012

4.2.1.4 ASSIGNING FACTOR VALUES TO SITUATIONS

TABLE XV

FACTOR VALUES MATCHED TO SITUATIONS FOR FACTOR I

ATTRIBUTE LEVELS Role	Part	Imp	Disc	FACTOR VALUE	KENDALL'S W	COMMENTS ON THE SIGNIFICANCE OF W
DM	UL	U	F	LOW	.2368	Significant at the .05 level
DM	UL	I	F	HIGH	.7885	Significant at the .05 level
DM	UL	U	D	INT	.0005	Not significant at the .10 level
DM	UL	I	D	HIGH	.7465	Significant at the .05 level
DM	SL	U	F	INT	.0228	Not significant at the .10 level
DM	SL	I	F	HIGH	.6640	Significant at the .05 level
DM	SL	U	D	INT	.0425	Not significant at the .10 level
DM	SL	I	D	HIGH	.6920	Significant at the .05 level
DM	UH	U	F	INT	.0035	Not significant at the .10 level
DM	UH	I	F	HIGH	.8332	Significant at the .05 level
DM	UH	U	D	INT	.0476	Not significant at the .10 level
DM	UH	I	D	HIGH	.8083	Significant at the .05 level
DM	SH	U	F	INT	.0845	Not significant at the .10 level
DM	SH	I	F	HIGH	.7543	Significant at the .05 level
DM	SH	U	D	HIGH	.1624	Significant at the .05 level
DM	SH	I	D	HIGH	.8033	Significant at the .05 level
DR	UL	U	F	LOW	.8319	Significant at the .05 level
DR	UL	I	F	INT	.0405	Not significant at the .10 level
DR	UL	U	D	LOW	.4616	Significant at the .05 level
DR	UL	I	D	INT	.0977	Not significant at the .10 level
DR	SL	U	F	LOW	.8182	Significant at the .05 level
DR	SL	I	F	INT	.0821	Not significant at the .10 level
DR	SL	U	D	LOW	.5682	Significant at the .05 level
DR	SL	I	D	INT	.0936	Not significant at the .10 level
DR	UH	U	F	LOW	.5666	Significant at the .05 level
DR	UH	I	F	INT	.0839	Not significant at the .10 level
DR	UH	U	D	LOW	.5942	Significant at the .05 level
DR	UH	I	D	INT	.0646	Not significant at the .10 level
DR	SH	U	F	LOW	.5526	Significant at the .05 level
DR	SH	I	F	INT	.0612	Not significant at the .10 level
DR	SH	U	D	LOW	.3598	Significant at the .05 level
DR	SH	I	D	INT	.0222	Not significant at the .10 level

Note: The level of significance is calculated using the rules for M = 23 and N = 3 For significance at the .10 level W >= .1009 and at the .05 level W >= .1301

Based on the results shown in Table XV and the earlier discussion of the addition of the True Decision Ratifier level for the attribute User Role (see note on Table XII) we can state seven rules for determining the Factor Value for "User Participation in the Decision Making Process" (an equivalent Decision Tree is presented in Chapter V):

1) IF the Decision Maker is a True Decision Ratifier
   THEN the factor value will be LOW.
   (Used to determine factor value in 16/48 situations.)

2) IF the Decision Maker is operating in a Decision Ratifying Role
   AND the Problem is Unimportant
   THEN the factor value is LOW.
   (Used to determine factor value in 8/48 situations.)

3) IF the Decision Maker is operating in a Decision Ratifying Role
   AND the Problem is Important
   THEN the factor value is INTERMEDIATE.
   (Used to determine factor value in 8/48 situations.)

4) IF the Decision Maker is operating as a Decision Maker
   AND the Problem is Important
   THEN the factor value is HIGH.
   (Used to determine factor value in 8/48 situations.)

5) IF the Decision Maker is operating as a Decision Maker

AND the Problem is Unimportant

AND the System was Solicited and the User Participated in its development

AND IF the User is Discretionary

THEN the factor value is HIGH

ELSE IF the User is Forced

THEN the factor value is INTERMEDIATE

(Used to determine factor value in 2/48 situations)

6) IF the Decision Maker is operating as a Decision Maker

AND the Problem is Unimportant

AND the User either Solicited the system or Participated in its development (but not both)

THEN the factor value is INTERMEDIATE.

(Used to determine factor value in 4/48 situations.)

7) IF the Decision Maker is operating as a Decision Maker

AND the Problem is Unimportant

AND the User neither Solicited the system, nor Participated in its development

AND IF the User is Discretionary,

THEN the factor value is INTERMEDIATE

ELSE IF the User is Forced

THEN the factor value is LOW.

(Used in determining factor value in 2/48 situations.)

4.2.1.5 USE OF A SINGLE MEASURE FOR LEVEL OF PARTICIPATION

As has been previously discussed in section 4.2.1.1, it should be possible to define a single variable to represent the value of the Level of User Participation in the Decision Making Process. A simple way of converting from the three dependent variables to a single one could be the following formula:

Value = 50*(2*ValueH + ValueI)/(ValueH + ValueI + ValueL)

This corresponds to setting up a scale, which appears to correctly map the extreme scores correctly, that is:

1) A respondent who gives ValueH a score of 100, and ValueI and ValueL scores of 0 has a score for VALUE of 100.
2) A respondent who gives ValueL a score of 100, and ValueI and ValueH scores of 0 has a score for VALUE of 0.
3) A respondent who gives each of ValueH, ValueI and ValueL a score of 50, has a score for VALUE of 50.

The system however tends to be conservative, in that it tends to force other responses towards the midpoint. For example a respondent who gives ValueH a score of 75, ValueI a score of 50, and ValueL a score of 25 has a score for value of 66.7. If we assume equal intervals for High, Intermediate and Low ranges on the scale, this is on the border between the Intermediate and High ranges, even though it is a situation where the respondent has indicated a preference for a High Level of Participation.

Even given the shortcomings that a simple conversion such as this has, it is useful in demonstrating that the resulting variable VALUE matches the data well and in most cases gives results that are consistent with the underlying data. We can compare this variable with ValueH and ValueL in Table XVI for the overall situation. The comparison of individual regression analysis is similar, with the mean value of R^2 of .80 for VALUE as compared to one of .795 for ValueH and .76 for ValueL, and the distribution of values of R^2 being similar.

TABLE XVI

COMPARISON OF REGRESSION RESULTS FOR VALUEH VALUEL AND VALUE IN FACTOR I

Function	ValueH		ValueL		Value	
Multiple R	.74595		.72437		.74760	
Multiple R**2	.55644		.52471		.55891	
Adj R**2	.55396		.52205		.55644	
F	224.2		197.3		226.5	
Sig (F)	.0000		.0000		.0000	
Attributes entered	T	Sig T	T	Sig T	T	Sig T
Role	22.23	.0000	-22.24	.0000	23.39	.0000
Imp	19.14	.0000	-16.28	.0000	17.89	.0000
Part	5.33	.0000	- 4.39	.0000	5.16	.0000
Disc	2.87	.0043	- 3.25	.0012	3.52	.0005
Const	8.86	.0000	47.48	.0000	16.10	.0000

A complementary measure for matching factor values to situations can be obtained by taking the calculated variable VALUE and averaging it over all respondents. The overall scale can be split into intervals, and a factor value of High, Intermediate or Low can be assigned, based on the average score (see Table XVII). If the variable VALUE is a good representation of the underlying construct, then these two methods should agree on which factor value to use in any situation.

TABLE XVII

MATCHING VALUE TO FACTOR VALUE FOR FACTOR I

Value of "Value"	Factor Level
0 - .33	LOW
.34 - .66	INT
.67 - 1.00	HIGH

In 30/32 cases both measures are in agreement. In cases 1 and 15 where Kendal's W indicates little disagreement among judges, VALUE indicates an Intermediate value. Because of the relatively small number of respondents, only one or two individuals who rated this situation very differently from the majority could cause the average value to increase outside of a category. In the cases where the two measures disagreed the average scores of VALUE were (.40, .65) and it would take a small change in VALUE to move these from Intermediate to the factor value suggested by the Kendall-based analysis. This particular representation for the underlying construct has already been noted in the previous section to be susceptible to this type of conservative error.

Based on the high correlation coefficients when ValueH is regressed on ValueI and ValueL, the high level of agreement between a representation of the underlying concept and the direct method of determining factor value for each situation, and how well the data seems to match being described by this single dependent variable, it appears that there is indeed a single construct underlying Factor I.

4.2.2 ANALYSIS OF FACTOR II

TABLE XVIII

FACTOR II: PROBLEM SPACE COMPLEXITY

VALUES

Complex
Moderate
Simple

Name	Attribute
Unique	Problem Uniqueness
Pset	Problem Set Complexity
Data	Data Resource Complexity
Range	Range of Problems
Depend	Interdependence of Decisions
Struct	Problem Structure

Attribute	Levels
Unique	Unique or Recurrent (U,R)
Pset	Simple or Complex (S,C)
Data	Simple or Complex (S,C)
Range	Narrow or Wide (N,W)
Depend	Reciprocal or (Pooled or Sequential) (R,P)
Struct	Structured or Unstructured (S,U)

4.2.2.1 THE DEPENDENT VARIABLES FOR FACTOR II

For each situation, each respondent was asked to consider himself/herself to be a systems manager in a large corporation who had just been called into the Director of Personnel's office. They were then asked to state their preference for describing the situation as being either Complex, Moderately Complex or Simple, from the point of view of developing a support system for the decision maker in that situation. The initial case description and subsequent modifications are found in Appendix IV.

They were asked to state these preferences in a manner similar to that outlined for Factor I, and as a result the same issues about the dependent variables are addressed here; i. e. are they really representations of a single underlying construct? The three variables used to represent the responses were ValueC, ValueM, ValueS.

Regression analysis was used to determine if the various judges or raters exhibited consistency with respect to their policies. For this factor, for the first nine respondents there were only twenty three cases and six variables so that the number of degrees of freedom are limited and this might have affected whether or not attributes were found to be significant in the multiple regression equations. As a result, the .10 level of significance was found more frequently than it was for Factor I. The results of this analysis are shown in Table XIX.

The results displayed in Table XIX and Table XX indicate similar trends to those analyzed for Factor I. However, the problems caused by the correlation of the three dependent variables is exacerbated for this factor. For Factor I, ValueI could not be considered independently, because it was being used as an indeterminate state between ValueH and ValueL. However, for Factor II, the middle value (ValueM) does not correspond to an indeterminate state. Instead of treating the middle level as an indeterminate or uncertain responses (similar to the case with ValueI for Factor I), the respondents appear to have used Moderate as a distinct state. As observed during the interviews the apparent policy of many of the respondents was to first raise or lower their preference for defining the situation as Complex. Then based on that change, they would modify both their preference for defining the situation as Moderate, and their preference for defining the situation as Simple. However, some respondents still exhibited a tendency to base their overall policy on the two extreme responses, showing a high level of consistency in their policies for defining a situation as complex, and their policy for defining a situation as simple (9/24 respondents have R^2 greater than .7 for both ValueC and ValueS regressed against the attribute levels).

Evidence of the relationship between the dependent variables comes from analyzing the regression of ValueC on the other two dependent variables. When ValueC was regressed on ValueS alone, the mean value of R was .85, and only 10 respondents had R greater than .9 while 6 had R less than .8. The addition of the second variable (ValueM) into the regression equation increased the mean value of R to .93, and 20 of the respondents had correlation coefficients greater than .90, and only 2 less than .85.

TABLE XIX

REGRESSION RESULTS FOR VALUEC, VALUEM, VALUES AND VALUE OF FACTOR II

Respondent	R^2(C)	R^2(M)	R^2(S)	R^2(V)
Subject1	.87065	------	.72497	.83524
Subject2	.79588	.39790	.86692	.80518
Subject3	.89265	.43170	.81985	.88308
Subject4	.70407	.13710	.54599	.61202
Subject5	.91869	.83030	.49283	.75464
Subject6	.76479	.54630	.53310	.70210
Subject7	.86808	.76480	.79857	.79266
Subject8	.57105	------	.53995	.75039
Subject9	.95595	.36398	.68426	.95038
Subject10	.81535	.34140	.46236	.71002
Subject11	.64185	.27297	.52229	.57261
Subject12	.69946	.53717	.65149	.68613
Subject13	.91433	.56927	.49886	.85118
Subject14	.83457	.51683	.54950	.75785
Subject15	.88434	.10138	.48129	.72923
Subject16	.85315	------	.71511	.89346
Subject17	.88815	------	.52331	.77344
Subject18	.62139	.20994	.49760	.57602
Subject19	.62139	.75700	.55447	.66703
Subject20	.84015	.23971	.61026	.75634
Subject21	.88510	.28899	.71280	.77089
Subject22	.94735	.25536	.78332	.89572
Subject23	.81725	.30571	.79793	.82485
Subject24	.79395	.59227	.74357	.79622

Note: All correlations except those denoted by ----- are derived from regressions where the F test was significant at the .10 level or better.

TABLE XX

DISTRIBUTION OF R^2 FOR FACTOR II

R^2	ValueC Respondents	ValueM Respondents	ValueS Respondents	VALUE Respondents
< .7	4	21	15	5
.7 - .8	5	2	7	12
.8 - .9	11	1	2	7
> .9	4	0	0	1

Summarizing, the judges exhibited a consistent policy for ValueC (average $R^2(C) = .81$), but their policies were less consistent with respect to ValueS (average $R^2(S) = .63$), and not very consistent with respect to ValueM for which average $R^2(M) = .42$ and only 20 respondents had any consistent policy at all (see note on Table XIX).

The results of regressing ValueC against Value M and ValueS differ markedly from the results of a similar regression analysis performed for Factor I. For Factor I the addition of the second variable in the regression equation resulted in only a slight increase in the value of R. Also for Factor I, two respondents exhibited perfect correlation between ValueH and ValueL while none exhibited perfect correlation between ValueH and (ValueL in conjunction with ValueI). For Factor II, five of the respondents exhibited perfect correlation between ValueC and (ValueS in conjunction with ValueM), while none exhibited perfect correlation between ValueC and ValueS alone.

Therefore, because of the correlation between the dependent variables a single measure of the Problem Space Complexity was used in the overall analysis. This measure was calculated in the following manner :

IF (ValueC + ValueM + ValueS) > 100 THEN

VALUE = 50*(2*ValueC + ValueM)/(ValueC + ValueM + ValueS)

ELSE VALUE = (2*ValueC + ValueM)/2

This measure has the same conservative tendencies as the measure calculated for Factor I. However, this measure takes into account the tendency of several of the respondents to initially lower only ValueC to show a lessening of preference for describing the situation as complex while holding ValueM and ValueS constant. They would do this until they felt that a significant change in the situation had occurred after which they would increase ValueM as well. This tendency was particularly apparent over the last 12 situations when respondents who, despite having rated all these situations as complex, wished to differentiate among them.

4.2.2.2 SPECIAL FEATURES IN THE ANALYSIS

As described in Chapter Three, before the study it had been assumed that there were two sets of attributes defining this factor. It was believed that the three attributes in the first set would cause the problem space to be complex if any one of them was at a level which would increase the complexity of the system. Particularly Pset and Data were believed to dominate the determination of factor value strongly, so that only a subset of situations were tested.

After analyzing the results from the first nine respondents, two things became clear.

1) The attribute Unique was judged to have very little effect on the assessment of the situation by over half of the respondents. Those respondents who felt that the attribute had any effect, felt that the effect was small, and they differed in the direction of the effect.

2) The attributes Data and Pset were not as dominant in the sense that they could not determine the factor value individually.

As a result of this initial analysis, twelve additional situations were added to the instrument for the final fifteen interviews. For six of these situations: Unique was set to Recurrent, Data was set to Complex, Pset was set to Simple, and the three attributes were allowed to vary over the six relevant combinations. For the other six, the values of Data and Pset were reversed. These were the only additional situations of the 32 possible situations where only one of Pset or Data was set to Complex that it was necessary to consider since:

1) The attribute Unique apparently had little effect on the Factor value so it was given a set value eliminating the need to test sixteen situations.

2) The two situations with one of Pset or Data set to Complex and the other set to Simple, and Struct set to Structured, Depend set to Interdependent and Range set to Narrow were already being tested.

3) Since respondents had defined Problem Space Complexity as Complex for the situation with Pset and Data set to Simple, Struct set to Unstructured, Depend set to Pooled, and Range set to Wide, both situations where one of Pset or Data was set to Complex while the other three attributes remained at these levels would clearly be Complex as well.

4.2.2.3 ANALYSIS OF INDIVIDUAL RESPONSES

Using VALUE (as defined in section 4.2.2.1) the mean value of R^2 for the group was .76. This meant that the respondents, while still demonstrating a consistent policy with regards to VALUE, were less consistent than they had been with regards to ValueC. It must be noted that the measure VALUE is only a method for displaying that the underlying construct exists, and does not necessarily represent the optimal functional form of the construct. For the purpose of this analysis it is only necessary to demonstrate that an underlying construct exists.

For the group as a whole, when VALUE was regressed against the independent variables, R^2 for the group was .475, which is much lower than the mean value of R^2 for individuals. The minimum value of R^2 for any respondent was .57, which was about 20% larger than the group value.

It appears that the difference between the consistency displayed by individual judges and the lower level of consistency shown by the regression over all respondents may be caused by demographic factors, similar to the case for Factor I. For this second factor we can add one additional source of demographic variation to those listed for Factor I. Although the individuals selected as judges for the second and third cases were systems analysts, project managers or managers of IS functions, and therefore appropriate representatives of the subject space, they had different backgrounds. It is postulated that the difference in background of the individuals (i.e. whether they have an EDP background, or whether they could more properly be defined as having a user oriented background) could lead to a different view as to what level of Problem Space Complexity a given situation exhibits.

As mentioned previously, the attribute Unique was not significant in explaining the variation in responses. If VALUE is regressed with Unique as the sole explanatory variable over all respondents, it is statistically significant, but it explains less than 2% of the total variation. If VALUE is regressed on the set of all the attributes together over all respondents, then Unique doesn't enter into the regression equation at the .10 level of significance (Table XXII).

Only five of the 24 respondents have Unique enter into the regression expressions between VALUE and the six attributes (Table XXI and Table XXII). Over half of the respondents when explicitly asked, stated that they found Unique not to have a significant effect on whether or not the problem space was complex, and many of the rest felt its effect was minor (and differed on the direction of the effect). Therefore the attribute Unique was dropped from the model, as had been expected after the initial interviews.

TABLE XXI

SIGNIFICANCE OF ATTRIBUTES IN THE INDIVIDUAL REGRESSION EQUATIONS FOR FACTOR II

Name	Attribute Significance
Subject1	Unique, Pset not significant at .10, Data significant at .10
Subject2	Unique, Pset not significant at .10
Subject3	Unique, Depend not significant at .10
Subject4	Unique, Depend not significant at .10 Data, Range, Struct significant at .10
Subject5	Unique, Data, Range, Depend not significant at .10
Subject6	Unique, Range not significant at .10
Subject7	Unique, Pset, Depend not significant at .10
Subject8	Pset, Depend not significant at .10
Subject9	Unique, Range not significant at .10
Subject10	Unique not significant at .10
Subject11	Unique not significant at .10, Data significant at .10
Subject12	Unique, Range not significant at .10
Subject13	All significant
Subject14	Range, Depend not significant at .10
Subject15	Unique not significant at .10, Depend significant at .10
Subject16	Unique not significant at .10
Subject17	Unique not significant at .10
Subject18	Range, Depend significant at .10
Subject19	Unique not sig. at .10, Range, Depend significant at .10
Subject20	Unique, not significant at .10
Subject21	Unique, Range not significant at .10
Subject22	Unique not significant at .10
Subject23	All significant
Subject24	Unique not significant at .10, Depend significant at .10

Note : All attributes not mentioned were significant at the .05 level

TABLE XXII

SIGNIFICANCE OF VARIOUS ATTRIBUTES FOR FACTOR II

Attribute	No. of times sig at .05	No. Of Times sig at .10	Multiple R^2	T	Sig(T)
Struct	23	24	.14803	14.37	.0000
Data	20	23	.14630	14.53	.0000
Pset	20	20	.09029	12.39	.0000
Range	15	18	.05709	8.02	.0000
Depend	14	18	.03349	6.88	.0000
Unique	5	5	------	- 1.59	.1123

The results of performing an ANOVA on the data show that the main effects explain about 50 % of the variance, but the two-way interactions explain about 6% of the variance. The two major interactions are between Data and Struct and Pset and Struct. Since these are the three attributes which have the largest effect on whether or not the situation is Complex it is not unrealistic to assume that these attributes will have a synergistic effect, in that if two of them are at levels that would cause the situation to become Complex, then it becomes Complex.

Another explanation of the interaction effects would be that it is an artifact of the unbalanced nature of the experimental design. In order to reduce the number of situations that the respondents had to consider, all possible combinations of attribute levels were not presented. Only those combinations that were undominated were used. However, the only significant interaction terms that were found were those that could logically have been expected.

The presence of interaction terms has some significance in terms of the model. It has been assumed that the attributes are orthogonal, and that a linear relationship between the variables exists, so a proper measure of the consistency of the judges' ratings is the R^2 from a linear regression. If there is substantial correlation between attributes, then R^2 will underestimate the level of consistency of the judges' ratings. The existence of correlation between the attributes may explain why the mean value of R^2 for Factor II is slightly lower than the mean value of R^2 for Factor I.

4.2.2.4 ASSIGNING FACTOR VALUES TO SITUATIONS

Table XXIII shows how the model matches situations to factor levels. For this factor, values were only assigned to the situations where Kendall's W was significant. Indeterminate situations were not to be assigned the factor value Moderate, but were to be left as indeterminate. This was because of the ability of the respondents to identify three unique values for this factor. Using the procedure outlined in section 4.2, levels of significance for W were calculated. For the .05 level (M = 24, N = 3) W = .1248. For the .10 level of significance W = .0967.

For all 36 cases using Kendall's W we were able to define a unique factor value as being most preferred at either the .05 or .10 level of significance. Because of the small number of respondents (15) for the final twelve situations it was necessary to use the .10 level of significance. The factor value chosen by dividing the range of VALUE into three equal partitions agreed with these predictions in 27 of 36 cases. But in all cases of disagreement it was within 5% of the factor level selected by Kendall's W, and it exhibited the conservative error discussed earlier. That is, it assigned a factor value of Moderate to situations that were assigned a factor value of Complex by Kendall's W.

For Factor II, because all three variables were used in the definition of the situation, this conservative bias may have been increased. As shown in Table XXIV we can improve the match between factor values assigned to situations by VALUE and those by the Kendall's W analysis, by changing the association between VALUE and the Factor levels to take into account the bias.

Five of the nine cases of disagreement occur in the last twelve situations. Most of the respondents indicated that the situations were complex, as is evidenced by the large values of Kendall's W. This is also shown by using the Wilcoxon matched pairs method to compare the rank of ValueM against ValueC. For 11/12 of these situations there is a significant difference in the ranking of these variables, despite the small number of cases (15) in the sample. In the one situation where there was no significant difference, nine respondents felt the situation was more complex than moderate, as opposed to five who felt it was more moderate than complex, and one who was indifferent. Because of the conservative bias of this measure it is possible to have situations that are clearly ranked as complex, yet are rated as moderate. Table XXIV shows how slight adjustments to the range of the factor value Moderate improves the agreement between these two measures.

TABLE XXIII
FACTOR VALUES MATCHED TO SITUATIONS FOR FACTOR II

Unique	Pset	Data	Range	Depend	Struct	Factor	W	Sig. Level	VALUE
U	C	C	W	R	U	COMPLEX	.9185	.05	87
U	C	C	N	S	S	COMPLEX	.7147	.05	72
U	S	C	N	S	S	MODERATE	.3144	.05	59
U	C	S	N	S	S	MODERATE	.1255	.05	52
U	S	S	N	S	S	SIMPLE	.3825	.05	31
R	S	C	N	S	S	MODERATE	.2369	.05	57
R	C	S	N	S	S	MODERATE	.0984	.10	51
R	C	C	N	S	S	COMPLEX	.8164	.05	74
R	S	S	W	R	U	COMPLEX	.8352	.05	76
R	S	S	N	R	U	COMPLEX	.3765	.05	64*
R	S	S	N	S	U	MODERATE	.1567	.05	52
R	S	S	N	S	S	SIMPLE	.6767	.05	25
R	S	S	W	S	S	MODERATE	.1591	.05	44
R	S	S	W	R	S	MODERATE	.1441	.05	52
R	S	S	N	R	S	MODERATE	.1988	.05	41
R	S	S	W	S	U	COMPLEX	.4026	.05	66*
U	S	S	W	R	U	COMPLEX	.8338	.05	74
U	S	S	N	R	U	COMPLEX	.3551	.05	63*
U	S	S	N	S	U	MODERATE	.0987	.10	51
U	S	S	N	S	S	SIMPLE	.5213	.05	27
U	S	S	W	S	S	MODERATE	.1993	.10	43
U	S	S	W	R	S	**MODERATE	.0963	.10	50
U	S	S	N	R	S	MODERATE	.1746	.05	40
U	S	S	W	S	U	COMPLEX	.2538	.05	62*
R	C	S	N	R	U	COMPLEX	.8083	.05	71
R	C	S	N	S	U	COMPLEX	.6887	.05	65*
R	C	S	W	S	S	COMPLEX	.6679	.05	65*
R	C	S	W	R	S	COMPLEX	.6621	.05	69
R	C	S	N	R	S	COMPLEX	.4905	.05	64*
R	C	S	W	S	U	COMPLEX	.7770	.05	72
R	S	C	N	R	U	COMPLEX	.8292	.05	72
R	S	C	N	S	U	COMPLEX	.6759	.05	68
R	S	C	W	S	S	COMPLEX	.6048	.05	66*
R	S	C	W	R	S	COMPLEX	.6655	.05	69
R	S	C	N	R	S	COMPLEX	.5083	.05	62*
R	S	C	W	S	U	COMPLEX	.7944	.05	72

Notes : **Although the significance test for .10 uses W = .0967, since this is an approximation we can say that W = .0963 is approximately significant at the .10 level.

*Disagreement between Kendall's W and VALUE for level of Factor Value

TABLE XXIV

VARIATION BETWEEN MODELS FOR DIFFERENT PARTITIONS OF VALUE FOR FACTOR II

NUMBER OF SITUATIONS IN AGREEMENT WITH W	BOUNDS ON MODERATE LEVEL OF VALUE
27	33 < VALUE < 67
31	35 < VALUE < 65
34	37 < VALUE < 63
36	37 < VALUE < 62

The five attributes fall into two sets. The attributes that are most important in determining the factor value are Pset, Data and Structure. The "less" important attributes are Range and Depend. This is close to original expectations.

For the following rules (based on the results displayed in Table XXIII) the attribute levels that add complexity to the system are: (Pset = Complex),(Data = Complex), (Range = Wide), (Depend = Reciprocal), (Structure = Unstructured). An equivalent Decision Tree can be found in Chapter Five.

Rules for determining Factor II Values based on Attribute Levels

(1) The attribute Unique doesn't need to be considered in setting factor values and will be dropped from the model.

(2) If none of the attributes is set to a level which would add complexity to the system, then the problem space complexity is simple.

(3) If only one of the attributes is set to a level which would add complexity to the system, then the problem space complexity is moderate.

(4) If only Range and Depend are set at levels which would add complexity to the system, then the problem space complexity is moderate.

(5) If any two or more attributes (other than Range and Depend alone) are set at levels which will add complexity to the system, then the problem space complexity is complex.

4.2.3 ANALYSIS OF FACTOR III

TABLE XXV

FACTOR III: RESOURCE AVAILABILITY

VALUES

Null
Simple
No_constraints
Decision Making Systems Approach

Name	Attribute
Develop	Developer Task Comprehension
User	User Systems Development Comprehension
Tech	Availability of Technology
Time	Availability of Time to Develop Specific Systems
Person	Availability of Systems Personnel

Attribute	Levels
Develop	Experienced, Inexperienced (E,I)
User	Experienced, Inexperienced (E,I)
Tech	Available, Unavailable (A,U)
Time	No Constraints, Constraints (N,C)
Person	Available, Low Availability (A,L)

4.2.3.1 THE DEPENDENT VARIABLES FOR FACTOR III

For each of the situations each respondent was asked to consider himself/herself to be the systems manager in a large corporation who had just been called into the Director of Personnel's office. They were then asked to state their preference for describing the level of Resource Availability as either Null, Simple or No Constraints. The fourth value of this factor (DMSA) was not tested for explicitly.

However, there was unanimity from the respondents that, if there was no human expertise in the decision making process, then the only thing that could be done was to develop a DMSA. The initial case and the modifications are found in Appendix IV.

The factor values were defined in terms of the effect of Resource Availability on the system that could be developed as follows:

1) If the resource constraints were too severe, then nothing could be done (Null).
2) If the resource constraints posed no major problems, one could develop the complete system the user had requested (No Constraints)
3) If serious resource constraints existed, one could develop a base or initial system (Simple).

The data analysis procedure was the same as for the other two factors and similar issues with regards to subject responses and response patterns need to be addressed. The three variables used to represent the responses are ValueN, ValueS, ValueNC. The results of the regression analysis for the three dependent variables are found in Table XXVI, as are the results for the regression analysis on VALUE. VALUE represents a single measure of the underlying construct of Resource Availability, and it has been calculated from the three measured dependent variables using an analogous algorithm to that developed for Factor II.

```
IF  (ValueN + ValueS + ValueNC) > 100
THEN  VALUE = 50*(2* ValueNC + ValueS)/(ValueNC + ValueS +ValueN)
ELSE  VALUE = 2*ValueNC + ValueS
```

The calculated measure VALUE has the same conservative bias as has been discussed for Factor I and Factor II.

The three factor values were highly correlated. From Table XXVIII the two extreme values (ValueN and ValueNC) were more highly correlated with each other than either was with ValueS. When ValueNC was regressed on ValueN the mean correlation coefficient R was .74, indicating a significant correlation. However when ValueNC was regressed on both ValueN and ValueS the mean value of R was .91 (.92 if one omits the lone outlier where R was less than .75). Also eighteen of the 25 respondents had R >.9 and three had R = 1.00 when ValueN and ValueS were in the equation. None of the respondents had a policy with perfect correlation between any two of the dependent variables. This appeared to indicate that in general, the policies of the respondents involved all three factor values in a fashion similar to that found with Factor II. However it should be noted that some respondents had no consistent policy at all for one of the Factor Values (shown in Table XXVI as an entry of ----- in the column of various R^2 values), so their exact policy would differ from the norm.

TABLE XXVI

INDIVIDUAL REGRESSION RESULTS FOR FACTOR III

Respondent	R^2(N)	R^2(S)	R^2(NC)	R^2(V)
Subject1	.87226	.47756	.62894	.78188
Subject2	.86082	.14325	.78991	.88917
Subject3	.83896	------	.89229	.88273
Subject4	.61024	.09826	.83336	.87913
Subject5	.78494	-----	.72126	.84003
Subject6	.80420	-----	.81488	.89659
Subject7	------	.61149	.78065	.61819
Subject8	.62774	------	.66010	.77040
Subject9	.83616	.28533	.30330	.93809
Subject10	.68302	.09207	.82883	.93440
Subject11	.78495	------	.86348	.88272
Subject12	.68175	------	.90174	.85586
Subject13	.72913	.21960	.77879	.83516
Subject14	.72480	.08870	.88154	.84924
Subject15	.63959	.11255	.88841	.88371
Subject16	.83926	.60045	.65121	.79312
Subject17	.67611	.25469	.74918	.81789
Subject18	.54613	.19192	.90596	.82519
Subject19	.53314	.67941	.87394	.84649
Subject20	.80916	.63548	.82791	.89606
Subject21	.79111	.10515	.89709	.91711
Subject22	------	.74376	.76091	.78677
Subject23	.73354	------	.66307	.78096
Subject24	.82087	.67977	.92549	.90939
Subject25	.51362	.54664	.76185	.81141
Mean	.72811	.34557	.78310	.84487

Notes: 1) For ValueN the mean is taken over 23 subjects with consistent policies, for ValueS over 19 subjects with consistent policies.

2) If we ignore Subject9 who exhibits little consistency for ValueNC, the mean increases to .80.

3) All results except those denoted by ------ are from regressions where the value of the F test was greater than .10.

TABLE XXVII

DISTRIBUTION OF R^2 FOR FACTOR III

R^2	ValueN Respondents	ValueS Respondents	ValueNC Respondents	VALUE Respondents
< .6	3	13	1	0
.6 - .7	6	5	4	1
.7 - .8	6	1	7	5
.8 - .9	8	0	10	15
> .9	0	0	3	4

TABLE XXVIII

CORRELATION COEFFICIENTS FOR VALUENC kEGRESSED ON VALUEN AND VALUES FOR FACTOR III

Subject	ValueS (Alone)	ValueN (Alone)	Both
Subject1	.36585	.92549	.93593
Subject2	.02411	.96707	.97463
Subject3	.17437	.91685	.91685
Subject4	.60648	.65083	.93954
Subject5	.37975	.71398	.93465
Subject6	.36806	.81418	.90610
Subject7	.65368	.43481	.80215
Subject8	.45384	.63509	1.00000
Subject9	.19101	.33333	.97145
Subject10	.34022	.67508	.81051
Subject11	.15344	.87437	.94601
Subject12	.13230	.79006	.93683
Subject13	.74633	.78566	1.00000
Subject14	.35437	.74059	1.00000
Subject15	.41633	.77501	.91907
Subject16	.63078	.83411	.83411
Subject17	.10361	.68611	.75526
Subject18	.46738	.82545	.99835
Subject19	.89669	.69461	.95546
Subject20	.90610	.73097	.92975
Subject21	.09748	.61682	.61682
Subject22	.82800	------	.82800
Subject23	.14885	.75381	.94213
Subject24	.89955	.93410	.97644
Subject25	.74633	.63767	.87034

Notes: 1) Subject 22 felt that you could always do something therefore ValueN = 0 for all cases. All other correlations, regardless of the significance of the F test are quoted.
2) For ValueN (alone) and Both all F tests are significant at the .10 level except as noted.

The results from regressing the factor values against the attributes for individual respondents (Table XXVI) showed:

1) there was a significant consistency of the subjects' policies with respect to ValueNC (mean value of R^2 = .78 with one significant outlier omitted R^2 = .80).

2) there was a significant policy with respect to ValueN (mean value of R^2 = .73 for the 23 respondents who had variables enter the regression equation), although it appears to be less consistent on average than the policy for ValueNC.

3) there was no consistent policy overall for ValueS (mean value of R^2 = .35 and 6/25 respondents had no attributes enter the regression equation). In fact only 7 of the 25 respondents had values of $R^2 > .5$.

It was not possible to determine how respondents considered the three factor values, other than that they considered them as a highly correlated triplet. Some respondents showed a more consistent policy with respect to ValueN rather than ValueNC, others showed a more consistent policy with respect to ValueS over either ValueNC or ValueN (although no one had their most consistent policy for ValueS). Therefore, unlike the situation with Factor I where the middle factor value was an indeterminate state, all three factor values must be taken as representing definable levels of the underlying construct. As was the case with Factor II we could only assign factor values to those situations where Kendall's W was significant (See Table XXX).

4.2.3.2 ANALYSIS OF THE INDIVIDUAL RESPONSES

The mean over all respondents of the correlation coefficients obtained from the regression of VALUE against the attributes was .85, which indicates a high degree of consistency among respondents with respect to an overall assessment of Resource Availability. For Factor III the consistency with regards to the overall policy is higher than with regards to the "policies" representing individual factor values (Table XXVI). For the group as a whole when the dependent variables representing the Factor values and VALUE were regressed against the attributes, the value of R^2 for ValueNC was the largest (.51), followed by the value for VALUE, (.50) then ValueN, (.36) and ValueS (.05) (F test significant at the .05 level). All respondents had values of R^2 for Value greater than the group value whereas for the other dependent variables there were individuals who had either inconsistent or relatively inconsistent policies. This indicates that the respondents did have some form of overall policy for the concept of resource availability.

As with Factor II the difference between the consistency displayed by the individual judges, and the lack of consistency shown by the regression over all respondents, is most likely the result of demographic factors, including the background of the individual judge. Table XXIX shows how often the individual attributes enter into the regression equations for individual judges or raters.

TABLE XXIX

SIGNIFICANCE OF DIFFERENT ATTRIBUTES FOR FACTOR III

Attribute	# of Times Sig	R**2	T	Sig(T)
Time	25	.16531	16.24	.0000
User	21	.08212	11.45	.0000
Person	21	.07998	11.30	.0000
Tech	21	.09405	12.25	.0000
Develop	21	.08105	11.37	.0000

Note the number of times each attribute entered into an individual's regression equation. For this factor most respondents felt that time was the most significant attribute, but still found all the attributes to be significant. At the .10 level of significance fourteen of the 25 respondents had all five attributes enter the regression equation for VALUE. Eight had four attributes enter the regression equation and only three of the twenty five respondents had less than four attributes enter into the regression equations.

4.2.3.3 ASSIGNING FACTOR VALUES TO SITUATIONS

Table XXX displays how well the model matches situations to factor values for this factor. It has been assumed that the individual respondents were able to identify three distinct factor values. Using the procedure outlined previously the levels of significance for W have been calculated for M = 25, N = 3 as:

at the .05 level W >= .1199

at the .10 level W >= .0928

At the .05 level of significance 30/32 situations can be uniquely associated with a given resource availability level. If we look at VALUE and split the range into three equal segments we can associate VALUE <= 33 with NULL, 33 < VALUE <= 66 with SIMPLE and VALUE > 66 with NO_CONSTRAINTS. Then in the 30 situations where there is a factor value assigned by Kendall's W, the descriptor associated with Value is the same as the factor value assigned by Kendall's W. In two situations (situation 6 and situation 12), the value of VALUE is 67, which is on the boundary between the NO_CONSTRAINTS and SIMPLE ranges whereas the Kendall analysis shows the rankings tied.

In both these situations although the value of W appears to suggest that there is a significant concordance, and hence one of the levels can be uniquely matched to the situation, the mean rankings of SIMPLE and NO_CONSTRAINTS are tied. Also the value of VALUE is on the boundary between the ranges associated with these two factor values. For Factor I (section 4.2.1.1) if there was no clear preference between the three factor values, then that indicated an indeterminate situation, and the middle factor value (Intermediate Level of Participation) was considered to represent an indeterminate state. For this factor (Factor III), because it appears that the factor values represent distinct states, it is not clear that this is the desired course of action. However, a conservative assumption would be to consider significant constraints to exist if the respondents were evenly split about whether

TABLE XXX

FACTOR VALUES MATCHED TO SITUATIONS FOR FACTOR III

Develop	User	Tech	Time	Person	Factor	W	Sig. Level	Value
E	E	A	A	A	NO_CONSTRAINTS	.8891	.05	95
E	E	A	A	U	NO_CONSTRAINTS	.6888	.05	79
E	E	A	U	U	SIMPLE	.4624	.05	61
E	E	A	U	A	NO_CONSTRAINTS	.7823	.05	79
E	E	U	A	A	NO_CONSTRAINTS	.7772	.05	86
!E	E	U	A	U	SIMPLE	.4369	.05	67
E	E	U	U	U	SIMPLE	.3256	.05	41
E	E	U	U	A	SIMPLE	.3460	.05	57
E	I	A	A	A	NO_CONSTRAINTS	.7689	.05	85
E	I	A	A	U	NO_CONSTRAINTS	.5475	.05	72
E	I	A	U	U	SIMPLE	.4279	.05	50
!E	I	A	U	A	SIMPLE	.5630	.05	67
E	I	U	A	A	NO_CONSTRAINTS	.4254	.05	71
E	I	U	A	U	SIMPLE	.2204	.05	52
E	I	U	U	U	NULL	.4577	.05	28
E	I	U	U	A	SIMPLE	.2484	.05	45
I	E	A	A	A	NO_CONSTRAINTS	.7634	.05	85
I	E	A	A	U	NO_CONSTRAINTS	.5991	.05	73
I	E	A	U	U	SIMPLE	.3903	.05	46
I	E	A	U	A	SIMPLE	.4229	.05	62
I	E	U	A	A	NO_CONSTRAINTS	.4309	.05	74
I	E	U	A	U	SIMPLE	.1831	.05	55
I	E	U	U	U	NULL	.4765	.05	29
I	E	U	U	A	SIMPLE	.3552	.05	47
I	I	A	A	A	NO_CONSTRAINTS	.3591	.05	69
I	I	A	A	U	SIMPLE	.1254	.05	53
I	I	A	U	U	NULL	.4699	.05	27
I	I	A	U	A	SIMPLE	.2770	.05	43
I	I	U	A	A	SIMPLE	.1345	.05	48
I	I	U	A	U	NULL	.4804	.05	29
I	I	U	U	U	NULL	.7537	.05	12
I	I	U	U	A	NULL	.4778	.05	22

Note: Situations marked with ! indicate problems with rankings as will be discussed below.

or not significant constraints existed in a situation. Therefore we will assign the factor value SIMPLE (which indicates that constraints do exist) to both of these situations.

Rules for Assigning Factor Values for Factor III

In the following rules, which are derived from the results displayed in Table XXX, the attribute levels that represent a lowering of Resource Availability are: (Develop = Inexperienced), (User = Inexperienced), (Tech = Unavailable), (Time = Constraints), (Person = Low Availability).

(1) If four or five of the attributes are at a level such that they would represent a lowering of the availability of resources for systems development (e.g. less time to develop the system), then no significant system can be developed.

FACTOR VALUE = NULL

(2) If three of the attributes are at values such that they represent a lowering of the available resources for systems development, then only a simple system can be developed.

FACTOR VALUE = SIMPLE

(3) If no more than one of the attributes is at a value such that it would represent a lowering of the available resources for systems development, then there are no significant constraints on the systems development.

FACTOR VALUE = NO_CONSTRAINTS

(4) If two of the attributes are at values such that they represent a lowering of the available resources for systems development, then :

a) if one of the unavailable resources is TIME, then only a simple system can be developed.

FACTOR VALUE = SIMPLE

b) otherwise there are no significant constraints on the systems development effort.

FACTOR VALUE = NO_CONSTRAINTS)

Rule 4(b) is supported in five of the six situations it applies to, with the exception of situation 6 which is discussed above. Note that with this one exception, these four rules define the selection of factor value for all 32 situations.

4.2.4 ANALYSIS OF FACTOR IV

TABLE XXXI

FACTOR IV: ORGANIZATIONAL CONTEXT

VALUES
Supportive
Non Supportive

Name	Attribute
Success	Previous History of MIS Projects
Resist	Organizational Resistance to Change
Endorse	Official Endorsement
Environ	Organizational Environment

Attribute	Level
Success	Successful(S)/Unsuccessful(U)
Resist	Resistance to Change(R)/Supportive of Change(S)
Endorse	Official Endorsement(O)/Little Support (L)
Environment	Supportive(S)/Non Supportive(N)

4.2.4.1 THE DEPENDENT VARIABLES FOR FACTOR IV

For each situation each respondent was asked to consider himself/herself to be the systems manager in a large organization. They had been called into the Director of Personnel's office. They were asked to assess their preferences for defining the Organizational Context as either Supportive or Non Supportive. Since this assessment had nothing to do with the technical aspects of systems development but was more of a general management issue, the respondents for this factor were the same as for Factor I, and had administrative rather than systems backgrounds. The dependent variables describing the preference were labeled ValueN and ValueS. The initial case and the subsequent modifications are found in Appendix IV.

The methodology was similar to that used for the first three factors. However, some of the issues that have been addressed were not of importance here. There were only two values associated with the fourth factor, so most respondents essentially used a zero sum strategy for answering. That is, if their preference for describing the situation as supportive dropped by 10 points (say from 90 to 80) from one situation to the next their preference for describing the situation as non-supportive rose by 10 points (from 10 to 20). Eleven of the 23 respondents had a correlation coefficient of 1.00 between ValueS and ValueN and only three had correlation coefficients of less than .95. Therefore although results are shown for both dependent variables, it is clear that we could represent the underlying construct as a single variable ValueS.

Another problem stemmed from the small number of cases. There were only sixteen data points for each individual and four variables, so the number of degrees of freedom was reduced. This may have had some effect on certain measures; e.g. the level of significance at which the attributes entered into the regression equations. However, as can be seen from the following table the overall regression showed a higher degree of consistency between all respondents than for any of the other factors. This may have been because of the relative significance of the attributes, or it may have been an artifact of the small number of data points.

TABLE XXXII

OVERALL REGRESSION RESULTS FOR VALUES AND VALUEN FOR FACTOR IV

Function	ValueS		ValueN	
Multiple R	.81180		.79949	
Multiple R**2	.65902		.63918	
Adjusted R**2	.65526		.63521	
F	175.39		160.76	
Sig F	.0000		.0000	
Attribute Entered	T	Sig T	T	Sig T
Endorse	17.89	.0000	-16.90	.0000
Resist	16.17	.0000	-15.63	.0000
Success	9.78	.0000	- 9.76	.0000
Environ	4.96	.0000	- 4.25	.0000
Constant	2.97	.0032	48.51	.0000

All four of the attributes were significant at the .0001 level in the overall regression (Table XXXII) and this seemed to indicate that they all were significant in the respondents' view in determining the value of Organizational Context. When performing regression analysis on the individual respondent's answers this was only partially supported. In Table XXXIII we can see that less than half of the respondents found the attribute Environ to be significant. However since 10/23 did find it significant, and since overall it was significant, this attribute was kept in the model.

4.2.4.2 ANALYSIS OF THE INDIVIDUAL RESPONSES

TABLE XXXIII

SIGNIFICANCE OF ATTRIBUTES FOR FACTOR IV

Attribute	Number of Respondents who found Attribute Significant	
Significance Level	.05	.10
All	8	10
Environ	10	12
Success	16	18
Resist	21	23
Endorse	23	23

TABLE XXXIV

COMPARISON OF REGRESSION RESULTS FOR VALUES AND VALUEN FOR FACTOR IV

Respondent	R^2(VALUES)	R^2(VALUEN)
Subject1	.95672	.98028
Subject2	.93016	.93016
Subject3	.86001	.84529
Subject4	.79927	.79927
Subject5	.94737	.87288
Subject6	.88677	.75578
Subject7	.77645	.87417
Subject8	.89544	.83008
Subject9	.89210	.89210
Subject10	.95605	.88438
Subject11	.90061	.85410
Subject12	.93738	.93738
Subject13	.97192	.97192
Subject14	.73582	.83690
Subject15	.91233	.91233
Subject16	.91007	.91007
Subject17	.85738	.85738
Subject18	.83994	.83438
Subject19	.93777	.93281
Subject20	.89492	.89492
Subject21	.95199	.95199
Subject22	.94907	.94907
Subject23	.83142	.83142

Note: 1) All results come from regression equations that have F tests significant at the .05 level.

TABLE XXXV

DISTRIBUTION OF R^2 FOR FACTOR IV

R2	# of Respondents (S)	# of Respondents (N)
.7-.8	3	2
.8-.9	8	12
.9-1.0	12	9

For six of the individuals it made a significant difference if we used inclusion limits of .10 as opposed to .05. The mean of the regression coefficient (for all individuals) rose from .86 (for limits of .05) to .89 for limits of .10 (for ValueS, the results are similar for ValueN). When the .10 limits were used every respondents' R^2 was higher than the overall R^2, and the average was higher than the overall value of R^2 (.89 vs .65). Furthermore by using the .10 level of significance the number of respondents who rated all four attributes as significant rose from eight to ten.

If we also consider Table XXXVI, it could be argued that there were two types of attributes, those that were reasonably dominant (Endorse,Resist) and which at the .10 level are seen as being important by all respondents, and those which were less important (Success,Environ).

TABLE XXXVI
SIGNIFICANCE OF VARIOUS ATTRIBUTES FOR FACTOR IV

		ValueS		
Attribute	R^2	T	Sig T	No. Times Sig.
Endorse	.30048	17.89	.0000	
Resist	.24568	16.17	.0000	
Success	.08975	9.78	.0000	
Environ	.02311	4.96	.0000	

		ValueN		
Attribute	R^2	T	Sig T	No. Times Sig.
Endorse	.28375	-16.90	.0000	
Resist	.24275	-15.63	.0000	
Success	.09475	- 9.76	.0000	
Environ	.01793	- 4.25	.0000	

4.2.4.3 ASSIGNING FACTOR VALUES TO SITUATIONS

For 13/16 of the situations a unique factor value has been assigned at the 5% level of significance (using a T-test or the Wilcoxon matched pairs test, see Table XXXVII). At the 10% level for either test, a unique factor value has been assigned to 15/16 situations. The other situation is indeterminate.

Analysis of the results has shown that only one situation has been identified that is neither supportive or non-supportive in the set of sixteen situations presented. The high degree of consistency with which most of the respondents have developed policies with respect to this factor, and the high level of correlation between the measures for both factor values have demonstrated that there is a unique underlying construct. In a full implementation of the model, it may be more appropriate to measure the level of organizational support using some form of interval or ratio scale, rather than using a dichotomous variable. Since an underlying construct does exist, this should not be difficult and will be discussed in detail in Chapter Five.

TABLE XXXVII

FACTOR VALUES MATCHED TO SITUATIONS

ATTRIBUTE LEVELS					T-TEST		WILCOXON	
Success	Resist	Endorse	Environ	Factor	T	Sig T	Z	Sig Z
S	S	O	S	SUPP	14.90	.000	-4.20	.0000
S	R	O	S	SUPP	3.68	.001	-2.88	.0039
S	R	L	S	NON	- 5.35	.000	-3.64	.0003
S	S	L	S	SUPP	2.40	.025	-2.25	.0242
U	S	O	S	SUPP	6.64	.000	-3.72	.0002
U	R	O	S	NON	- 2.40	.025	-2.26	.0239
U	R	L	S	NON	-14.94	.000	-4.20	.0000
U	S	L	S	*NON*	- 1.84	.080	-1.82	.0680
S	S	O	N	SUPP	11.07	.000	-4.01	.0001
S	R	O	N	*SUPP*	2.04	.054	-1.88	.0605
S	R	L	N	NON	-10.92	.000	-4.11	.0000
S	S	L	N	******	- .11	.916	- .20	.8405
U	S	O	N	SUPP	3.92	.001	-2.99	.0028
U	R	O	N	NON	- 4.47	.000	-3.22	.0013
U	R	L	N	NON	-15.48	.000	-4.20	.0000
U	S	L	N	NON	- 4.55	.000	-3.40	.0007

Note 1) *value* implies that the factor value is only significant at the .10 level of significance.
2) ***** implies that no factor value can be assigned.

Rules for Determining Factor IV Values

These rules are derived from the results displayed in Table XXXVII, and in the decision tree shown in Figure IX in Chapter Five.

(1) IF NO MORE THAN ONE OF (SUCCESS = S OR RESIST = S OR ENDORSE = O) OR NONE OF THESE THREE ARE TRUE THEN VALUE = "NON SUPPORTIVE" ELSE VALUE = "SUPPORTIVE".
(2) IF ENVIRON = N AND ENDORSE = L AND RESIST = S AND SUCCESS = S THEN VALUE = INDETERMINATE.

4.2.5 SUMMARY OF THE SECOND PHASE RESULTS

The original model was developed based on the assumption that it was possible to describe situations in terms of a hierarchical model. Based on this it was hypothesized that it was possible to describe a set of overall factors, each of which was described by a set of attributes. Then, by knowing the attribute levels in a given situation one could assign factor values to a given situation. By knowing the factor values one could then assign a "best systems development approach" to the situation.

The Delphi panel validated the content of the model, by agreeing to the factors and their underlying attributes. The first two sets of interviews also helped to validate the model structure, by demonstrating that the attributes selected by the panel were indeed considered to be significant in determining factor values (with the exception of the attribute Unique of Factor II). It also provided some confirmation as to the independence or lack of independence between the attributes, and justification that the factors as represented by sets of attributes, did indeed represent single constructs.

The individual respondents for all four of the factor studies showed a relatively high level of consistency in their responses with respect to the underlying constructs. This was critical given the idiographic-statistical tenets of Social Judgment Theory. Given the consistent behavior of the individual respondents, one could then look at the concordance with which the respondents applied their judgments. For the four factors considered, a total of 116 situations were presented to two panels of judges. An analysis of the responses of the subjects was able to assign a unique factor value to 115 of these situations.

4.3 ANALYSIS OF THE THIRD PHASE OF THE VALIDATION PROCESS

The two goals of the third phase were to provide additional evidence of the content validity of the model, and to help to provide information on how the model could be implemented.

To meet these goals, three objectives were developed.

The first objective was to determine the characteristics of the independent variables, that is:

1) The adequacy of the set of factors developed during the Delphi study. One measure of adequacy was the consistency that the respondents displayed in using some internal policy to determine various preferences for the different approaches in each situation.

2) Which factors were significant in selecting specific approaches for developing support systems.

3) What was the relative importance of each factor.

This would provide supporting evidence to the Delphi Study on the validity of the top level of the hierarchical model.

The second objective was to determine which approach or approaches would be preferred in each situation (unique set of factor values). This was the first step in the process of implementing the model, and the final step in the validation of the model structure.

The third objective was to develop a prototype instrument for determining which factor values in a given situation would improve the probability of successfully using a given systems development approach.

The third objective was only partially met, in that decision trees for the various levels of the model hierarchy were developed (see Chapter Five Figures VII to XI), and a backtracking algorithm defined, but no formal prototype has yet been developed.

The four factors used in the model, their values and the acronyms used to describe them are given in Table XXXVIII.

TABLE XXXVIII

OVERALL MODEL

FACTOR NAME	DESCRIPTION
Participation	User Participation in the Decision Making Process
Complexity	Problem Space Complexity (From a Systems Development Perspective)
Resource	Resource Availability
Organization	Organizational Context (Supportiveness)

FACTOR NAME	VALUES	
Participation	High, Intermediate, Low	(H,I,L)
Complexity	Complex, Moderate, Simple	(C,M,S)
Resource	Null, Simple, No Constraints, DMSA	(N,S,NC,DMSA)
Organization	Supportive, Non Supportive	(S,NS)

4.3.1 DEPENDENT VARIABLE

The respondents for the Third Phase were asked to assume that they were systems managers of a large organization who had been asked by the Director of Personnel to help develop a system to aid in employment equity compliance. They were asked to state their preference for each of the five systems development approaches. The respondents were asked to state their preferences as scores from 0 to 100, 0 meaning no preference for a particular approach, 100 meaning as strong a preference as possible. They were told that they did not have to normalize their responses over the five different approaches, but were asked to be as consistent as possible, i.e. a higher score would be taken to mean a stronger preference. For the purpose of analysis the responses were normalized and are represented by dependent variables as outlined in Table XXXIX and defined in Appendix II. The initial case and the subsequent modifications can be found in Appendix V.

Table XL demonstrates the high level of correlation between the different systems development approaches. From Table XL, the average multiple correlation coefficient between ValueD1 and the other dependent variables is .87. Also 16/24 respondents have correlation coefficients greater than .85 and all respondents have correlation coefficients greater than .72. This high degree of correlation poses a significant new problem. Whereas the dependent variable in the second phase represented one underlying construct, the approach taken to develop a support system is a complex high level construct with at least two underlying low level constructs (level of participation and level of complexity). From Table XL we see that for each of the other four dependent variables at least two respondents considered that variable to be the most highly correlated with ValueD1. Some of the approaches represented by these variables (i.e. Null, SDLC) could only be considered as being opposite in value or representing the other extreme type of approach to the DMCA represented by ValueD1. Others (PA, DMSA) could be considered as being of similar value or representing a similar type of approach to DMCA. Therefore the variation in the level of correlation between ValueD1 and the other dependent variables gives an indication that different types of response patterns were used by different individuals.

TABLE XXXIX

SYSTEMS DEVELOPMENT APPROACHES

APPROACH	LEVEL OF PARTICIPATION	LEVEL OF COMPLEXITY	DEPENDENT Variable
Null	----	----	ValueN1
Systems Development Life Cycle (SDLC)	Low	Low	ValueS1
Prototyping (PA)	High	Low	ValueP1
Decision Maker Centered Approach (DMCA)	High	High	ValueD1
Decision Making Systems Approach (DMSA)	Low	High	ValueE1

TABLE XL

MULTIPLE CORRELATION COEFFICIENTS FOR VALUED1 REGRESSED ON THE OTHER DEPENDENT VARIABLES

Respondent	Overall Correlation Coefficient	ValueN1	ValueS1	ValueP1	ValueE1
Subject1	.89130	.10842	**.88017**	.16405	.32834
Subject2	.75343	.37255	**.65983**	.51645	-----
Subject3	1.00000	.70081	**.80651**	.50370	.73234
Subject4	.91332	.35010	.72891	**.89914**	.27438
Subject5	.99736	.76856	.09081	**.98864**	.11823
Subject6	1.00000	.15246	**.69470**	.32643	.09939
Subject7	.76724	.34785	.11568	**.41086**	.17753
Subject8	.89457	.59248	.04648	**.65125**	.30849
Subject9	.72747	-----	**.62995**	.17630	.23092
Subject10	.72573	.34278	**.53607**	.20788	.01077
Subject11	.81635	.68729	.07593	**.72722**	.40809
Subject12	.77145	.42474	.49126	**.70892**	.10453
Subject13	.98990	.26172	.73118	**.98990**	-----
Subject14	.91041	-----	.68786	.45323	**.84412**
Subject15	.95768	.47057	.56892	.52889	**.77700**
Subject16	.80469	.73606	**.77842**	.42282	.40915
Subject17	.89612	.52459	**.77469**	.34588	.06923
Subject18	.87607	.51250	.58042	.69099	**.78777**
Subject19	.91207	.60934	**.69178**	.41037	.06239
Subject20	.85665	**.56263**	.42525	.40449	.19234
Subject21	.85268	**.82901**	.02129	.82347	.78184
Subject22	.72375	.35789	**.62817**	.54036	.26184
Subject23	.96612	-----	.86166	.79912	**.90353**
Subject24	.95099	.48348	**.84410**	.57300	.06369

Notes: 1) The second to fifth columns represent the simple correlation coefficient between ValueD1 and the other dependent variables.

2) The underlined simple correlation coefficients are the largest for each respondent. Eleven respondents found ValueS1 and ValueD1 to be the most highly correlated, seven ValueP1 and ValueD1, four ValueD1 and ValueE1, and two ValueD1 and ValueN1.

3) All correlation coefficients are shown regardless of the level of significance of the F test, however all overall coefficients are significant at the .01 level

The five system development approaches were defined in terms of both the level of participation required from the user in the development process, and the level of complexity (section 2.1.4.3). Therefore users could logically form at least three different policies with regards to how they would trade off among different approaches.

One of these policies represents a trade off between high and low participation approaches. Another represents the trade off between high and low complexity approaches. The third represents an attempt to take into account both constructs at the same time, and trade off among all five approaches. Therefore three measures are needed and we can develop these based on the approaches defined in Table XXXIX.

We can define a participation policy with a high participation state represented by:

ValueP1 + ValueD1,

a low participation state represented by:

ValueS1 + ValueE1,

and no participation represented by ValueN1.

We can define a complexity policy with a high complexity state represented by :

ValueE1 + ValueD1,

a low complexity state represented by:

ValueS1 + ValueP1,

and no complexity represented by ValueN1.

We can define overall measures for these policies which are analogous to the measures defined in phase two (4.2.1.5) for the underlying constructs. They are; a participation measure:

TOTPART = 0*ValueN1 + (ValueS1 + ValueE1) + 2*(ValueP1 + ValueD1)

and a complexity measure:

TOTCOMP = 0*ValueN1 + (ValueS1 + ValueP1) + 2*(ValueD1 + ValueE1)

We can then define the consistency the respondent has shown in using either policy as the value of R^2 from the regression analysis, with the appropriate measure (as defined above) as the dependent variable and the four factors as the independent variables.

For the third policy, under which the individual will be considered to set independent policies for each of the five approaches, it is not useful to define an overall measure. The consistency of the respondents with respect to this policy was defined as the average of R^2 for all of the approaches.

These measures represent a simplistic attempt to measure the underlying concepts and as such have many faults.

The participation and complexity policy measures suffer from the conservative bias that has been discussed earlier. ValueN which represents the non-normalized responses for preference for the Null approach enters into these measures only in the denominator of the normalization of the other variables.

An ANOVA of the overall responses provides evidence that respondents focused on either participation or complexity or used a policy involving all the responses. As Table XLI demonstrates, there was a lack of overall consistency between those respondents whose "best" policy was to look at all the approaches individually. This policy is most likely not a correct representation of their true policies, since for all respondents a high degree of correlation exists among the different systems development approaches.

One could logically formulate a number of different policies that respondents could have used to trade off among the different systems development approaches. Regression analysis, performed with measures of some of these policies serving as dependent variables, showed some individuals to be more consistent with respect to one policy than with respect to others. Logically the policy that best fits the data, i.e. that is the most consistent, should be the best representation of their decision making policy. However, the focus of this research is not to determine the different policies that the respondents have for differentiating among approaches for developing support systems.

For our purposes it is only necessary to show that on average the respondents individually exhibited some acceptable degree of consistency with any policy. We have shown that a simple set of policies exists, for which, on average, the respondents exhibited an acceptable level of consistency, (which should be lower than the level of consistency they would exhibit for their own true policies). Therefore we can assert that the individuals have exhibited the required consistency.

The three policies (Participation, Complexity and considering each approach independently) that are being used represent as simple a set of policies as could exist in these circumstances. This set of three policies is sufficient to demonstrate consistency, in that the average of the "best " of these three values of R^2 over all individuals is .74 (see Table XLIV), which meets the criteria ($R^2 > .72$) laid down at the beginning of this chapter. In section 4.3.3, a rationale for splitting the respondents into three groups is developed.

4.3.2 THE INDEPENDENT VARIABLE

Table XLI-A shows that, under the assumption that the respondents as a group used a policy of trading off between all five approaches, not only is there little evidence of consistency (low average R^2), but there is evidence that the policies are not orthogonal. Several different 2-way interactions were significant for the group as a whole, and the interaction effects were sizable when compared to the main effects.

TABLE XLI

RESULTS FROM ANOVA ANALYSIS OF DIFFERENT POLICIES

A: Overall Analysis of All Respondents (N = 24)

Function	ValueN1	ValueS1	ValueP1	ValueD1	ValueE1	Average
R^2	.2896	.1912	.1352	.4200	.1763	.2425
Ratio	.25	.38	.25	.07	.15	.22
2-Way Int	I - III I - IV II - III III- IV	I - III I - IV III- IV	I - III II - III III- IV	I - III II - III	I - III III- IV	
Factors Not significant		Complexity	Complexity	Complexity	Complexity	

B: Analysis for Respondents using Participation or Complexity Policies

	Participation Policy (N = 6)		Complexity Policy(N = 7)	
Function	TOTPART	TOTCOMP	TOTPART	TOTCOMP
R^2	.5296	.6754	.4636	.4983
Ratio	.03	.05	.12	.07
2-Way Int		I - IV	II - III	II - III III - IV
Factors Not Significant	Complexity			

C: Analysis for Respondents using Overall Policy (N = 11)

Function	ValueN1	ValueS1	ValueP1	ValueD1	ValueE1	Average
R^2	.2335	.2521	.0602	.4511	.1300	.2254
Ratio	.36	.08	1.23	.03	.10	.36
2-Way Int	I - III I - IV III- IV		I - IV III- IV			
Factors Not Significant	Complexity	Complexity	Complexity Resource	Complexity	Complexity	

Notes 1) Ratio = (sum of all 2-way, 3-way and 4-way interactions divided by the main effects).

2) Significance for the interactions and the factor values is at the .10 level.

3) The Roman numerals represent the corresponding factors i.e I = Factor I (User Participation in the Decision Making Process).

Table XLI-B shows that individuals who displayed a consistent policy for participation or complexity exhibited a high level of consistency, and the only two-way interactions that were significant were those that were expected to be significant, i.e. Factor I with Factor IV, Factor III with Factor IV, and Factor II with Factor III. A linear model is therefore a good representation for the respondents whose policies "matched" the participation or complexity policies outlined.
In fact, normally these respondents had a consistent policy for both complexity and participation with one being "better" than the other.

Table XLI-C shows that, among the responses from the eleven subjects whose decision making policy was best represented as considering each approach individually, there was a much less consistent response pattern. This can be explained by examining the individuals' responses. There are those whose decision policy appeared to involve trading off between all five of the approaches. There are others who displayed policies that appeared to involve a set of four of the five approaches. There are still others who appear to have more complex policies involving partitioning the five approaches into sets of approaches, and then trading off between the sets.

The results from an ANOVA of the responses from this group showed a large number of significant two-way interactions, as well as a substantial fraction of the total variation being explained by the interactions. This indicated that a linear model was not suitable for this group. However, it is believed that the number and the significance of the interaction effects is an artifact of the different ways in which individual respondents dealt with each dependent variable. If we had succeeded in matching each individual's true policy, there should be few interaction effects, as was the case with the individuals with participation or complexity policies.

Therefore for the purposes of the analysis of individual respondents, it has been assumed that a linear or near linear model, with only a small amount of the total variation being accounted for by two-way interaction effects, is the best representation of the system.

4.3.2.1 RESOURCE AVAILABILITY

For the purpose of the Third Phase of the study, Resource Availability has been operationalized as having two instead of four levels. Two of the levels of this factor assume that the level of Resource Availability can actually determine the approach that needs to be taken. That is, if the level of Resource Availability is very low, then nothing can be done and the Null approach is selected. This was agreed to by the participants in both the Second and the Third Phases. Similarly if the resource that is missing is human decision-making expertise in the user problem area, then the participants in both phases agreed that the only thing that could be done, if anything, would be to use a Decision Making Systems Approach and to develop a DMS.

4.3.3 INDIVIDUAL RESPONSES

To attempt to determine individual policies it is necessary to take into account the fact that for certain individuals one or more of the approaches did not form a part of their decision making process. For example, some of the respondents did not consider either the Null approach or the DMSA approach to be a valid alternative under any of the circumstances presented to them. Other respondents, while not saying explicitly that they would never use a particular approach, never had a significant preference for it. To measure the consistency with which respondents applied a particular policy, we needed to determine which approaches entered significantly into the formulation of their policies. Respondents could not be expected to exhibit a consistent policy for a systems development approach which only entered into their decision making process for one or two of 36 situations, given our technique for measuring consistency. In the light of these problems, the following rules were used to determine if an approach played a significant role in the respondents policy.

A particular approach would be included in the analysis for an individual if:

1) The respondent has shown a strong preference for using an approach in at least 10% of the situations (4/36). Here a strong preference is defined as being one of the respondent's top two preferences.
2) The preference for using the approach must be non-zero or different from a small constant value (e. g. a constant response of .10 or .05 for all situations) at least 20% of the time (i.e. in at least 8 of the 36 situations they must have a response different from zero or their normal small constant.)
3) R^2 was greater than .20.

The last rule served to eliminate those approaches which appeared to enter into the policies as a catch all; i.e. "If I logically can't do anything else then I'll do that". An approach that is used this way is legitimately part of a respondent's policy, but our linear regression analysis showed this as an inconsistent policy. This occurred for eight individuals. There were four for whom there was no consistent policy for ValueS (preference for using the SDLC approach). There were also four for whom there was no consistent policy for using ValueP (preference for using the Prototyping Approach). Both approaches could be described as using simple systems, so they fit the description of "something to do when you can't do anything else but you should be able to do something".

These preceding rules were used for eliminating respondents from the analysis when determining the average consistency of all the respondents over all approaches to supplying support systems (Table XLII). When the respondents were divided into three groups based on policy preference (Table XLIV), preferences for all approaches were considered for respondents who displayed either a Participative or Complex policy. The rules outlined above were only used for those who held an "overall" policy. Based on the following tables (Table XLII, Table XLIII, and Table XLIV) we can say that:

(1) All four factors were significant in determining the respondents' policies.

(2) Each respondent has exhibited consistent use of some underlying policy in determining which approach to use in a given situation.

(3) There are significant differences among respondents in the individual policies they have chosen, and in the consistency with which these policies are adhered to. This indicates that there are individual differences in the way that respondents solve the problem of selecting a systems development approach for supplying support to a decision maker.

Except for determining the relative importance of the various attributes, which will be discussed in section 4.3.4, we have met the first objective for the third phase.

TABLE XLII

RESULTS FROM THE REGRESSION ANALYSIS USING NORMALIZED VARIABLES

	R^2					
Respondent	ValueN1	ValueS1	ValueP1	ValueD1	ValueE1	Average
Subject1	.95263	.71417	.78976	.81159	-----	.8170
Subject2	.68806	.82783	.64344	.85514	-----	.7536
Subject3	.81930	.55020	.70639	.70675	.66279	.6891
Subject4	------	.78392	.83007	.84563	.69067	.7876
Subject5	.86544	------	.88675	.92347	.48940	.7901
Subject6	.33112	.55608	.53399	.44676	------	.4670
Subject7	.48835	.44681	.66803	.83748	.60956	.6100
Subject8	.76231	.58644	.66732	.80216	.70607	.7049
Subject9	------	.87399	.28386	.71503	.82250	.6738
Subject10	.49705	.62137	.49579	.85542	.36262	.5665
Subject11	.59293	------	.42238	.64900	.79428	.6145
Subject12	------	.80116	.41499	.79567	.55704	.6422
Subject13	------	.79984	.80341	.85712	------	.8201
Subject14	------	.82360	------	.69687	.72290	.7478
Subject15	.64448	------	.64929	.78112	------	.6916
Subject16	.78649	.93007	------	.80394	.50349	.7560
Subject17	.67350	.71080	.30338	.71055	.56992	.5936
Subject18	.41647	.49759	.20599	.58251	.57955	.4568
Subject19	.68126	.25231	.51385	.74397	.28915	.4961
Subject20	.69750	.28781	------	.66539	.60950	.5651
Subject21	.73832	------	.79746	.76891	.87068	.7938
Subject22	.34042	.64381	.73053	.77839	.48162	.5950
Subject23	------	.81840	.85928	.93595	.86280	.8691
Subject24	.41012	.75637	-----	.89714	------	.6879
Average	.6321	.6641	.6102	.7700	.6214	.66

Note : All results except those shown as ----- are from regression equations where the F test is significant at the .05 level.

TABLE XLIII

NUMBER OF RESPONDENTS FOR WHOM EACH FACTOR WAS SIGNIFICANT

Dependent Variable	PARTICIPATION	COMPLEXITY	RESOURCES	ORGANIZATION
ValueN1 (/18)	15	10	18	16
ValueS1 (/20)	19	12	17	13
ValueP1 (/20)	16	13	13	9
ValueD1 (/24)	24	14	22	17
ValueE1 (/18)	15	8	17	13

TABLE XLIV

RESULTS FROM REGRESSION ANALYSIS COMPARING DIFFERENT POLICIES

Respondent	R^2 TOTPART	TOTCOMP	AVERAGE	Policy Selected	Best R^2
Subject1	.34118	.39976	.8170	A	.8170
Subject2	.40367	.44548	.7536	A	.7536
Subject3	.77279	.76808	.6891	P	.7728
Subject4	.07996	.11419	.7876	A	.7876
Subject5	.82690	.74509	.7901	P	.8269
Subject6	.52292	.45843	.4670	P	.5229
Subject7	.34345	.26186	.6100	A	.6100
Subject8	.77588	.69124	.7049	P	.7759
Subject9	.77416	.79861	.6738	C	.7986
Subject10	.55735	.57021	.5665	C	.5702
Subject11	.42814	.50953	.6145	A	.6145
Subject12	.55096	.45409	.6422	A	.6422
Subject13	.13878	------	.8201	A	.8201
Subject14	------	.26926	.7478	A	.7478
Subject15	.84739	.88148	.6916	C	.8815
Subject16	.42584	.62701	.7560	A	.7560
Subject17	.85271	.81573	.5936	P	.8527
Subject18	.68338	.73251	.4468	C	.7325
Subject19	.63398	.62930	.4961	P	.6340
Subject20	.50681	.66404	.5651	C	.6640
Subject21	.77601	.80088	.7938	C	.8009
Subject22	.73803	.79777	.5950	C	.7978
Subject23	.79154	.59316	.8691	A	.8691
Subject24	.10678	.25226	.6879	A	.6879
Average					.739

Notes 1) There are 11 individuals who have a higher consistency if we assume that they have a policy of considering all the systems development approaches individually, 7 who have a higher consistency if we assume that they have a policy of focusing on the complexity of the approaches, and 6 who have a higher consistency if we assume that they have a policy of focusing on the level of participation in the development of the system.

2) A means that the selected policy is to use all approaches
P means that the selected policy is the participation policy
C means that the selected policy is the complexity policy

3) All results except those represented by ----- come from regression equations where the F test is significant at the .05 level.

4.3.4 MATCHING SYSTEMS DEVELOPMENT APPROACHES TO SITUATIONS

In attempting to match approaches for developing support systems to situations as described by the four factors, we used a methodology similar to that employed to determine factor values based on sets of attribute levels. However there was a major difference. When selecting factor values the factors represented some underlying construct. Therefore we used the assertion that the factor value with the "lowest mean ranking" (see section 4.2 for definition) was preferred if the value of Kendall's W was significant. When selecting which approach or approaches to recommend we were not dealing with one underlying construct. We attempted to determine if in fact the approaches were grouped together. Was one approach significantly different from the rest, or were two approaches significantly different from the rest.

In addition to Kendall's Coefficient of Concordance we also used the Wilcoxon Matched Pairs analysis between all pairs of approaches to determine if we could differentiate among groups of preferred systems.

In Table XLV the number of items to be judged (N) is five and the number of judges (M) is twenty-four. We have calculated the value of W for significance at the .01, .05 and .10 levels of significance.

At the .01 level	$W \geq .1353$.
At the .05 level	$W \geq .0982$
At the .10 level	$W \geq .0810$

TABLE XLV

MATCHING FACTOR VALUES TO SYSTEMS DEVELOPMENT APPROACHES

Factor Value				Kendall's	Sig.	Selected
FactorI	FactorII	FactorIV	FactorIII	W	W	Approach(es)
HIGH	COMPLEX	SUPPORTIVE	NO_CONST.	.8630	.01	DMCA (1)
HIGH	MODERATE	SUPPORTIVE	NO_CONST.	.8006	.01	DMCA (1)
HIGH	SIMPLE	SUPPORTIVE	NO_CONST.	.6831	.01	DMCA, PA (1)
INT.	COMPLEX	SUPPORTIVE	NO_CONST.	.6536	.01	PA, DMCA (1)
INT.	MODERATE	SUPPORTIVE	NO_CONST.	.7052	.01	PA, DMCA (1)
INT.	SIMPLE	SUPPORTIVE	NO_CONST.	.5565	.01	PA, DMCA (1)
LOW	COMPLEX	SUPPORTIVE	NO_CONST.	.3153	.01	SDLC, PA (4)
LOW	MODERATE	SUPPORTIVE	NO_CONST.	.3248	.01	SDLC, PA (4)
LOW	SIMPLE	SUPPORTIVE	NO_CONST.	.4237	.01	PA (4)
HIGH	COMPLEX	NON SUPP.	NO_CONST.	.5860	.01	PA, DMCA (1)
HIGH	MODERATE	NON SUPP.	NO_CONST.	.6397	.01	PA, DMCA (1)
HIGH	SIMPLE	NON SUPP.	NO_CONST.	.5859	.01	PA, DMCA (1)
INT.	COMPLEX	NON SUPP.	NO_CONST.	.4456	.01	PA (1)
INT.	MODERATE	NON SUPP.	NO_CONST.	.4096	.01	PA (2)
INT.	SIMPLE	NON SUPP.	NO_CONST.	.4135	.01	PA (3)
LOW	COMPLEX	NON SUPP.	NO_CONST.	.2061	.01	SDLC (1)
LOW	MODERATE	NON SUPP.	NO_CONST.	.2383	.01	SDLC (1)
LOW	MODERATE	NON SUPP.	NO_CONST.	.2895	.01	SDLC (2)
HIGH	COMPLEX	SUPPORTIVE	CONSTRAINTS	.4829	.01	PA (4)
HIGH	MODERATE	SUPPORTIVE	CONSTRAINTS	.5570	.01	PA (2)
HIGH	SIMPLE	SUPPORTIVE	CONSTRAINTS	.5816	.01	PA (2)
INT.	COMPLEX	SUPPORTIVE	CONSTRAINTS	.4447	.01	SDLC, PA (1)
INT.	MODERATE	SUPPORTIVE	CONSTRAINTS	.5314	.01	SDLC, PA (1)
INT.	SIMPLE	SUPPORTIVE	CONSTRAINTS	.6080	.01	SDLC, PA (2)
LOW	COMPLEX	SUPPORTIVE	CONSTRAINTS	.4151	.01	SDLC (1)
LOW	MODERATE	SUPPORTIVE	CONSTRAINTS	.5633	.01	SDLC (1)
LOW	SIMPLE	SUPPORTIVE	CONSTRAINTS	.5554	.01	SDLC (1)
HIGH	COMPLEX	NON SUPP.	CONSTRAINTS	.2810	.01	PA, SDLC (4)
HIGH	MODERATE	NON SUPP.	CONSTRAINTS	.3363	.01	PA (4)
HIGH	SIMPLE	NON SUPP.	CONSTRAINTS	.4160	.01	PA (4)
INT.	COMPLEX	NON SUPP.	CONSTRAINTS	.3536	.01	SDLC (4)
INT.	MODERATE	NON SUPP.	CONSTRAINTS	.3809	.01	SDLC, PA (4)
INT.	SIMPLE	NON SUPP.	CONSTRAINTS	.4525	.01	SDLC, PA (2)
LOW	COMPLEX	NON SUPP.	CONSTRAINTS	.3662	.01	N (1)
LOW	MODERATE	NON SUPP.	CONSTRAINTS	.3865	.01	N, SDLC (1)
LOW	SIMPLE	NON SUPP.	CONSTRAINTS	.4085	.01	SDLC (4)

In preparing Table XLV systems development approaches were selected using three rules. These rules represented an attempt to either assign a single systems development approach to each situation, or given no clear preference between the top two approaches, assign a pair of approaches to the situation. The three rules are:

1) If a systems development approach was indicated as the preferred approach by the Kendall coefficient of concordance, and there was a significant difference between the preference for this approach and all other approaches using a Wilcoxon Matched Pairs test, then this approach was considered to be the preferred approach at the .05 (1) or the .10(2) or .15(3) level of the Wilcoxon Matched Pairs test.

2) If there was no significant difference using the Wilcoxon matched pairs test between the preferences for the top two approaches (as defined by Kendall's W), but there was a significant difference between both of these approaches and the other three approaches, then these top two approaches were considered to be preferred at the .05(1) or the .10(2) level of significance of the Wilcoxon Matched Pairs test.

3) If the top approach (or the top two approaches) as defined by Kendall's W could not be separated from the other approaches by use of the Wilcoxon matched pairs analysis then the top approach was taken to be the preferred approach (4).

There were three exceptions to the last rule. In these situations there appeared to be almost no distinction between the top two approaches (similar to the situation discussed for Factor III in Section 4.2.3). For all three exceptions the two top approaches were SDLC and PA. Based on nearly identical rankings and the trend across different situations (see Table XLVI) both approaches were selected. There was only one case where significance at the .15 level was used.

TABLE XLVI

SELECTED SYSTEMS DEVELOPMENT APPROACHES

RESOURCE AVAILABILITY:		NO CONSTRAINTS		CONSTRAINTS	
ORGANIZATIONAL CONTEXT:		SUPPORTIVE	NON SUPPORTIVE	SUPPORTIVE	NON SUPPORTIVE
PARTICIPATION	COMPLEXITY				
	COMPLEX	DMCA	PA,DMCA	PA	PA,SDLC
HIGH	MODERATE	DMCA	PA,DMCA	PA	PA
	SIMPLE	DMCA,PA	PA,DMCA	PA	PA
	COMPLEX	PA,DMCA	PA	SDLC,PA	SDLC
INTERMEDIATE	MODERATE	PA,DMCA	PA	SDLC,PA	SDLC,PA
	SIMPLE	PA,DMCA	PA	SDLC,PA	SDLC,PA
	COMPLEX	SDLC,PA	SDLC	SDLC	NULL
LOW	MODERATE	SDLC,PA	SDLC	SDLC	NULL,SDLC
	SIMPLE	PA	SDLC	SDLC	SDLC

Note: Resource Availability levels NULL and DMSA have been omitted from this table since they force the approach selected to those values, no matter what the value of the other factors. They are included for completeness in the Decision Tree representation of the overall model shown in Figure X in Chapter Five.

One interesting trend was that in 26/36 of the situations the Kendall's ranking was verified by the Wilcoxon test between pairs of approaches. This indicated that the preferences were very strong for the selected systems development approaches in these situations. For the other ten, although the Kendall's W was significant at the .01 level, given the small sample size it was not possible to differentiate between the rankings based on the Wilcoxon test.

From Table XLVI we observe that, in general, as the support for the system development effort decreases, the selected systems development approach tends to become less complex. Also Resource Availability has more of an effect than the Organizational Context.

There was also a significant change in the approach selected as the User Participation decreased. There was less change as Problem Space Complexity changed. Only 5/12 sets of situations showed any change in approach selected as Problem Space Complexity changed with the other factors being held constant. In these five instances, only once did the selected systems development approach change for each change in value of Problem Space Complexity. This agreed with results from the regression analysis. These results showed that most individuals found Resource Availability and User Participation were the most important factors in determining their policies and that fewer individuals found Organizational Context or Problem Space Complexity to be as important.

Unlike the situation in Phase Two where simple sets of rules could be developed for determining factor value, no simple set of rules could be used to select approach(es) for each situation. We have now met the first two objectives, and have provided a further demonstration of the content validity of the model structure. The decision trees based on the results from this Chapter are found in Chapter Five.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 SUMMARY

This study has demonstrated that it is possible to develop a tool to aid in the selection of a support system for a given decision maker in a given organizational setting. While the model or theoretical basis for such a tool has been developed, the implementation of this model in a computer based support system (tool) has been left to follow-up studies. Development of such a tool will be possible despite the existence of a great many different attributes or factors which different researchers have found significant in the development of support systems for decision makers.

This research has demonstrated that a relatively small set (20) of these attributes are considered to be important in selecting which type of approach to use. Also, this research has shown that these attributes can be organized in a hierarchical structure with several low level constructs (attributes) defining each higher level construct (factor). This reduces the task of associating the appropriate systems development approach with each set of attribute levels from a practically intractable problem (with millions of different sets of attribute levels) to one that is more easily solvable with only hundreds of combinations to consider.

While developing this model some interesting facets of the complex interaction between computer based support tools, the development of these tools, and the decision making process have surfaced. This research showed a degree of consistency among respondents in how they associated sets of attribute levels with factor values. Given their particular policies, individual respondents also displayed consistency in how they associated sets of factor values with approaches for systems development. However, despite this consistency, based on the results of the last two phases of the research it appears that individual differences played a large role in how respondents reacted to this highly structured task.

In section 5.1 we will discuss the research results, in terms of the various assumptions on which this research was based. In section 5.2 we will discuss how this model could be implemented as a decision support system. In section 5.3 we will discuss future research studies suggested by this initial study.

5.1 DISCUSSION

The process of analysis involves the creation of models to help deal with the complexities of the real world. The construction of such models usually involves approximations or simplifications. The model developed in this research is hierarchical and describes the different situations for which support systems for decision makers may need to be developed in terms of four factors, each of which is defined by a set of attributes. In developing this model, some major assumptions were made. The validity of these initial assumptions can now be evaluated.

5.1.1 ASSUMPTION #1 : REDUCTION OF THE NUMBER OF ATTRIBUTES

The first major assumption underlying this research is that only the most important attributes needed to be considered.

During the Delphi study only those attributes which met certain consensus criteria were included in the study. The justification for the elimination of attributes was that it was not necessary to consider all possible attributes, only those that were considered either important by the majority of participants or very important by some of the participants. It was believed that leaving out attributes for which there was no consensus would create a model that would be more easily implemented and would still describe the majority of situations adequately. Also, it was felt that a smaller set of attributes, which the panel had agreed were important, was more likely to be orthogonal or nearly orthogonal than a large set with no consensus as to their importance. This is based on comments from individual respondents to the Delphi, who explained that they had rated certain attributes as unimportant or unnecessary if they felt they were too similar to other attributes.

Using a smaller set of attributes appears to have been an acceptable assumption. The respondents in the second phase displayed consistent policies for determining factor values based on attribute levels. Also there was an absence of feedback that there were missing attributes that were necessary to define the factor values. However perceptions about what is important or is not important change with time (witness the rise and fall of individual differences research in MIS over the past ten years). Therefore any model such as this will need periodic updating to keep current.

In the best of all worlds the attributes in the model would represent orthogonal constructs. Eliminating attributes which are strongly correlated tends to move the model in this direction. The statistical analysis of orthogonal models is simpler, and the presence of an orthogonal model would have made the subjects' tasks in the second phase simpler. In the real world operationalized constructs are seldom truly orthogonal but the ANOVA of the results of the second phase showed that most of the variance could be described by the main interactions, with the two-way and three-way interactions explaining much less of the total variation. This indicated that the attributes could be assumed to be orthogonal for the purposes of this model. Corroborating evidence can be found in a comparison of the multiple R^2 when all attributes are in the regression equation and the sum of the simple R^2 for each individual attribute regressed on a factor value. If the attributes were orthogonal, then these would be the same. For Factor I, Factor III and Factor IV these two quantities are equal to within roundoff errors. For Factor II the difference is about 1%.

5.1.2 ASSUMPTION #2: USE OF QUALITATIVE ATTRIBUTES

The second major assumption was that the attributes could be described as qualitative variables, usually implemented in either a dichotomous or three-leveled fashion.

In order to reduce the number of situations that had to be presented to the respondents of the questionnaires, and to simplify the task of operationalizing the attributes it was decided to study only the extreme points for most attributes. The underlying assumption was that as the attribute level changed between the extreme values, the effect that this change would have on its factor value would have some regular predictable form. By measuring the factor values for the extreme points, we would therefore be able to infer the factor values for intermediate points. An analysis of the factor values associated with each set of attribute levels (Chapter 4.2) shows that this appears to be the case. Changing individual attributes from one extreme point to the other produced effects of the form predicted. Based on this regularity we were able to develop a small set of rules for determining factor values based on attribute levels for each factor.

5.1.3 ASSUMPTION #3: THE HIERARCHICAL NATURE OF THE MODEL

The third major assumption is that the attributes could be grouped together as factors.

The Delphi study was the first step in the validation of this assumption. At the end of the third round, not only had the panel agreed on the attributes that they considered to be important, but they had agreed with which factor each attribute should be associated. They also had given some indication as to the factors they thought were correlated. For the same reasons given previously it would be useful if the factors were independent, both in terms of simplifying mathematical analysis, and in terms of simplifying the task of the respondents in the third phase. However as the experience from the initial round of the Delphi proved, humans do not necessarily view the world in terms of orthogonal constructs. Therefore the model included Factor IV, even though this factor was felt to be correlated to Factor I and to Factor III. Similarly it appeared that there would be a correlation between Factor II and Factor III based on the responses of the Delphi study and the literature search. Analysis of the data from the third phase of the research confirmed the correlations between both Factor I and Factor III with Factor IV. It also confirmed the correlation between Factor II and Factor III. For determining correlations, the only meaningful data was from the thirteen subjects in Phase III who had either a complexity policy or a participation policy. For those individuals without a specific policy it was not possible to say what the "true" correlations were.

However, even given these statistically significant correlations, the total variation explained by all interaction effects was less than 10% of the total variation explained by the main effects in Phase three of the study.

5.1.4 ASSUMPTION #4: USE OF A NOMINAL DEPENDENT VARIABLE

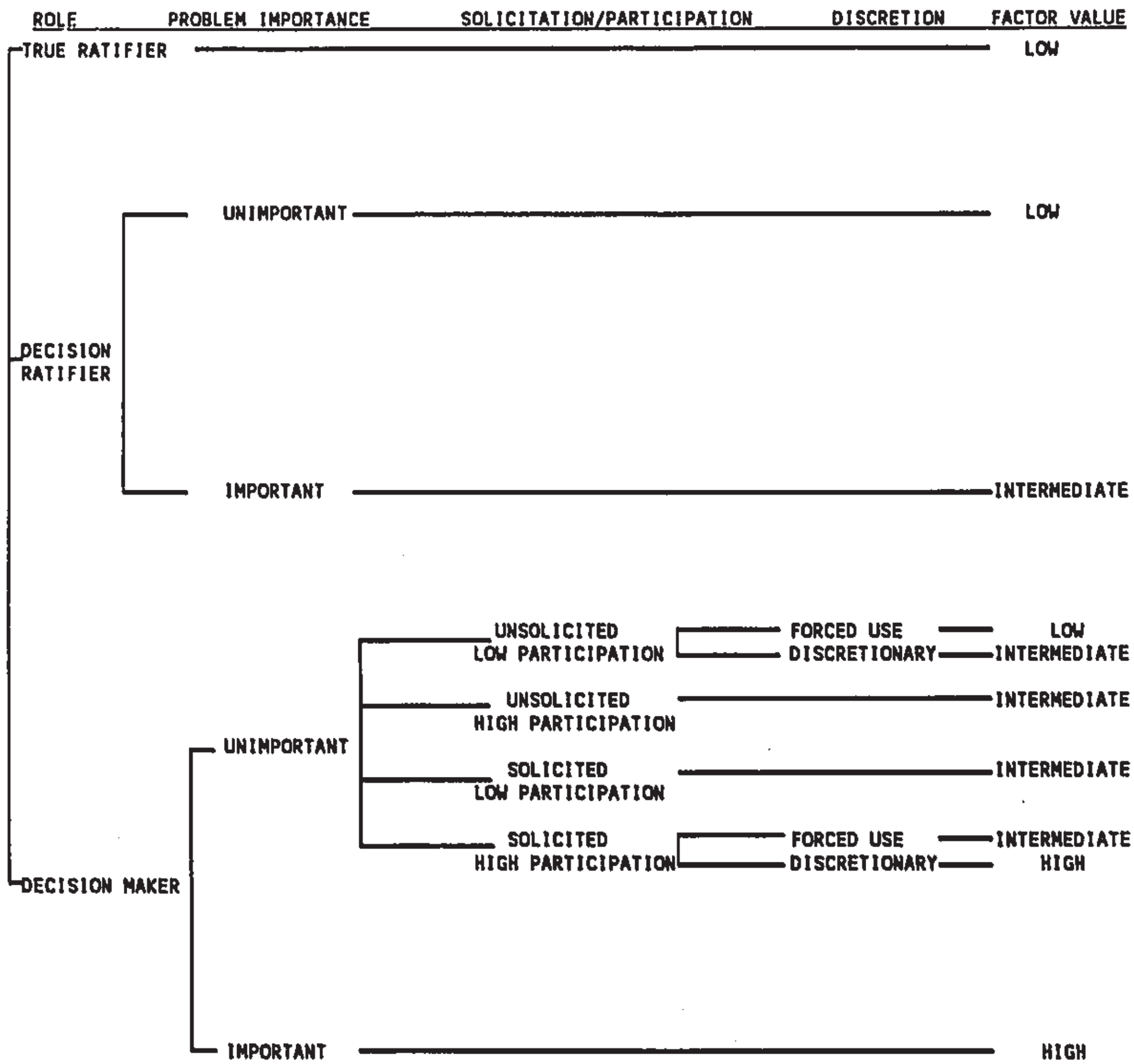
The last major assumption was that the dependent variables (approaches) could be adequately represented by a nominal variable implemented as a set of discrete approaches.

A plausible alternative would have been to represent the dependent variable by a set of continuous measures based on the underlying constructs (i.e. a set of process needs and development needs). However the list of systems development approaches appeared to be complete enough for an initial validation of the model. All but one of the subjects in the third phase of the study agreed that it was a simplified but adequate view of the world and all subjects who volunteered an opinion agreed that it represented the set of all possible approaches. The fact that most subjects developed some sort of consistent policy for selecting one of these approaches also suggests that a complete or nearly complete set of approaches was used.

5.2 IMPLEMENTATION OF THE MODEL

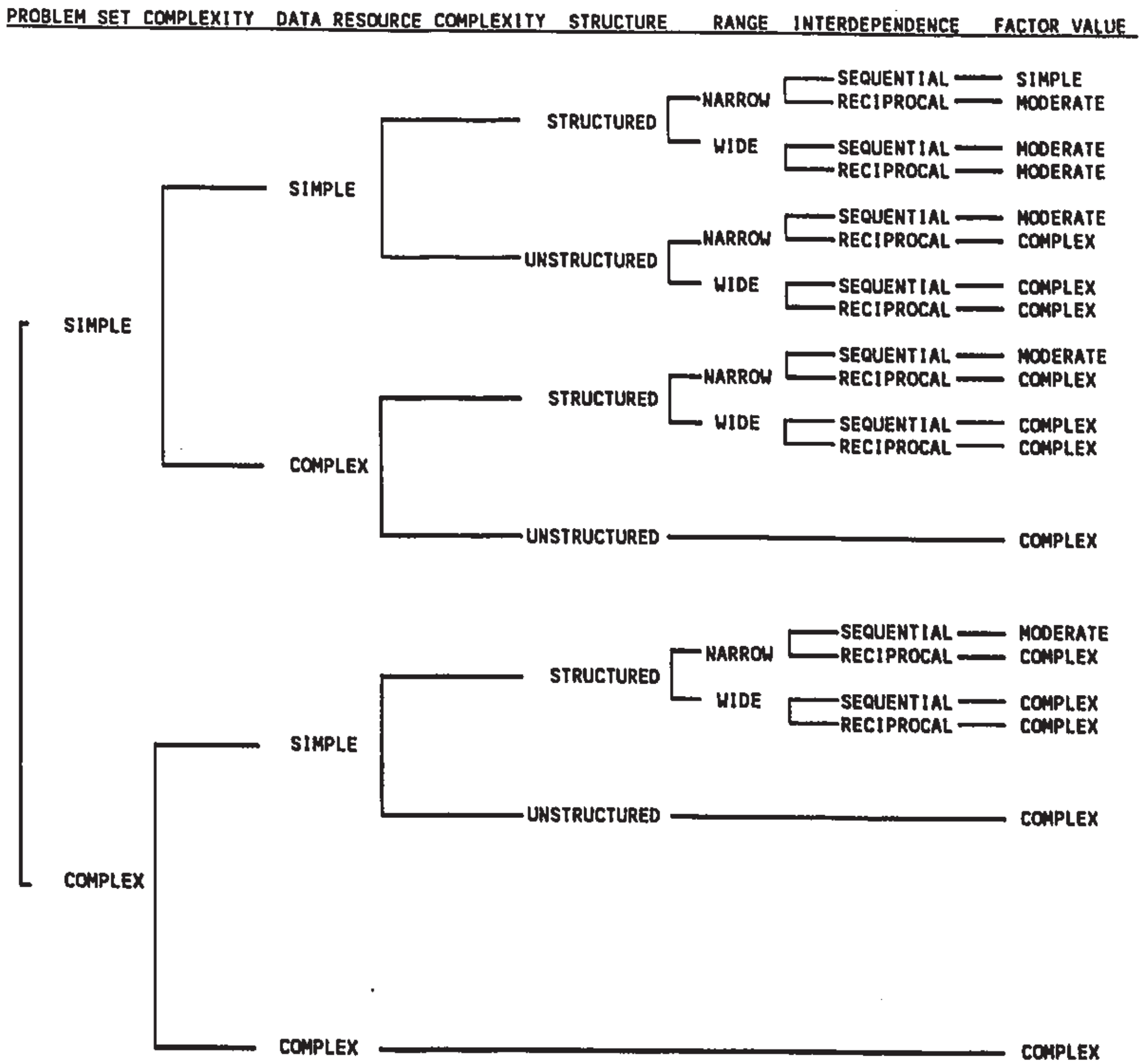
Currently the model defines factor values in terms of attribute levels, and suggests the appropriate systems development approach for situations that are defined in terms of factor values. (See Figures VI through X for a set of decision trees based on the rules and observations from Chapter Four.) If the model were to be implemented as a tool for aiding systems development personnel in providing computer based support to decision makers, it would need to be refined in several ways.

One area of refinement is in determining which of the attributes need to be looked at in more detail. From the results of Phase II of the study some of the attributes have more of an effect in determining the factor values than do others. For those attributes that have large roles in determining factor values it may be necessary to develop more precise scales for measuring attribute levels. Also, if we are to use more quantitative measures of attribute level, then we need to develop instruments to measure these attribute levels more precisely.



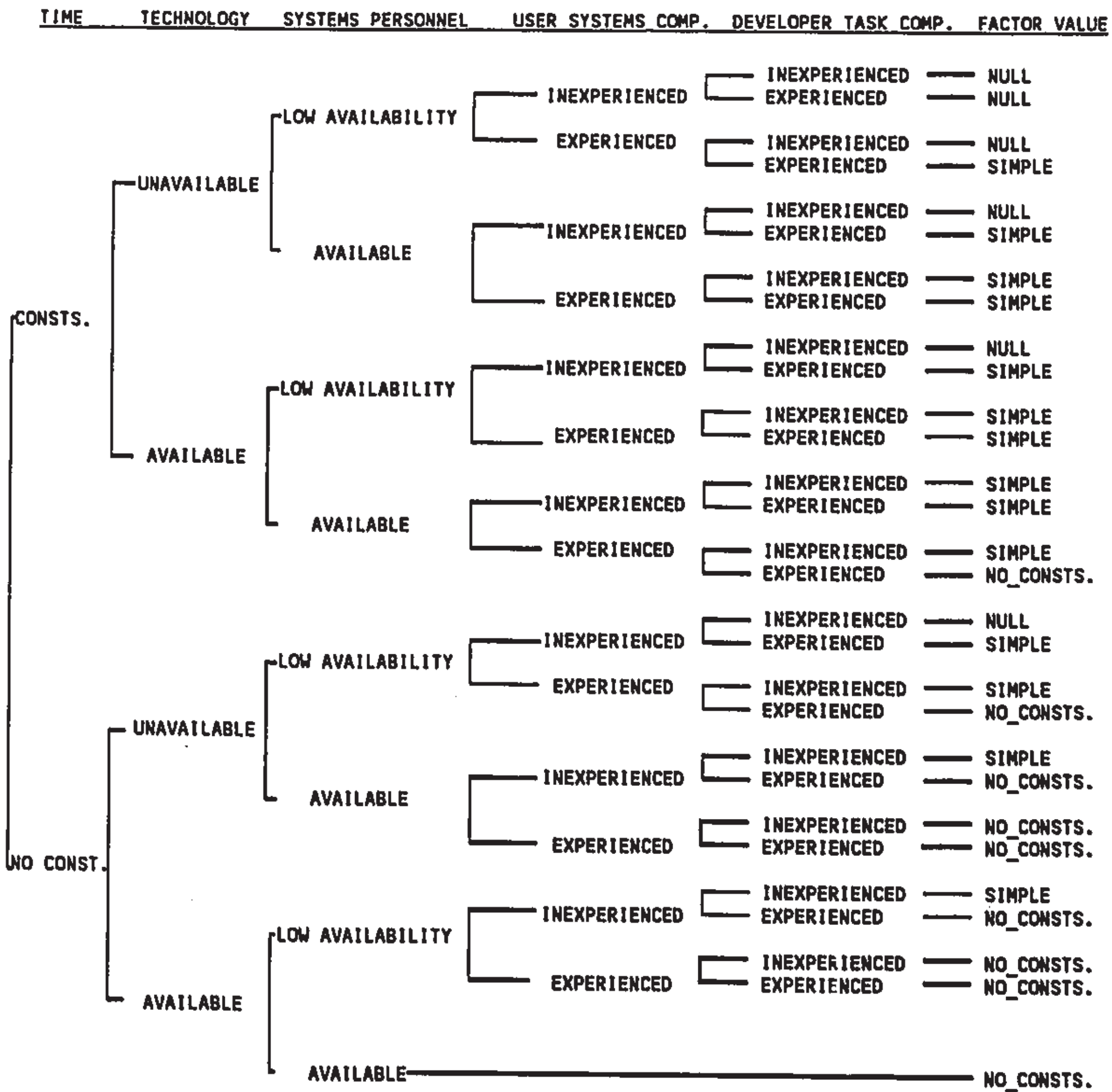
DECISION TREE FOR FACTOR I: USER PARTICIPATION IN THE DECISION MAKING PROCESS

FIGURE VI



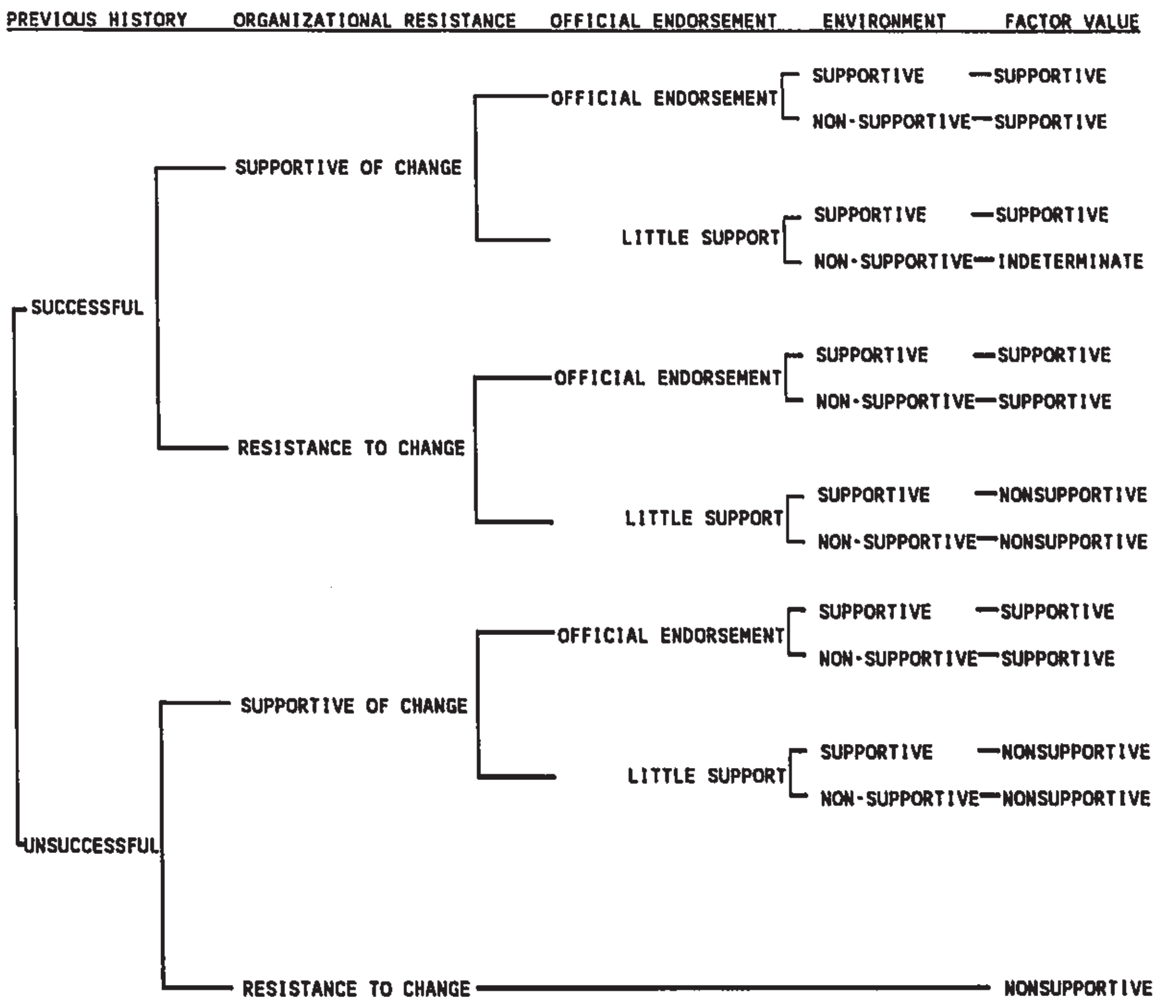
DECISION TREE FOR FACTOR II: PROBLEM SPACE COMPLEXITY

FIGURE VII



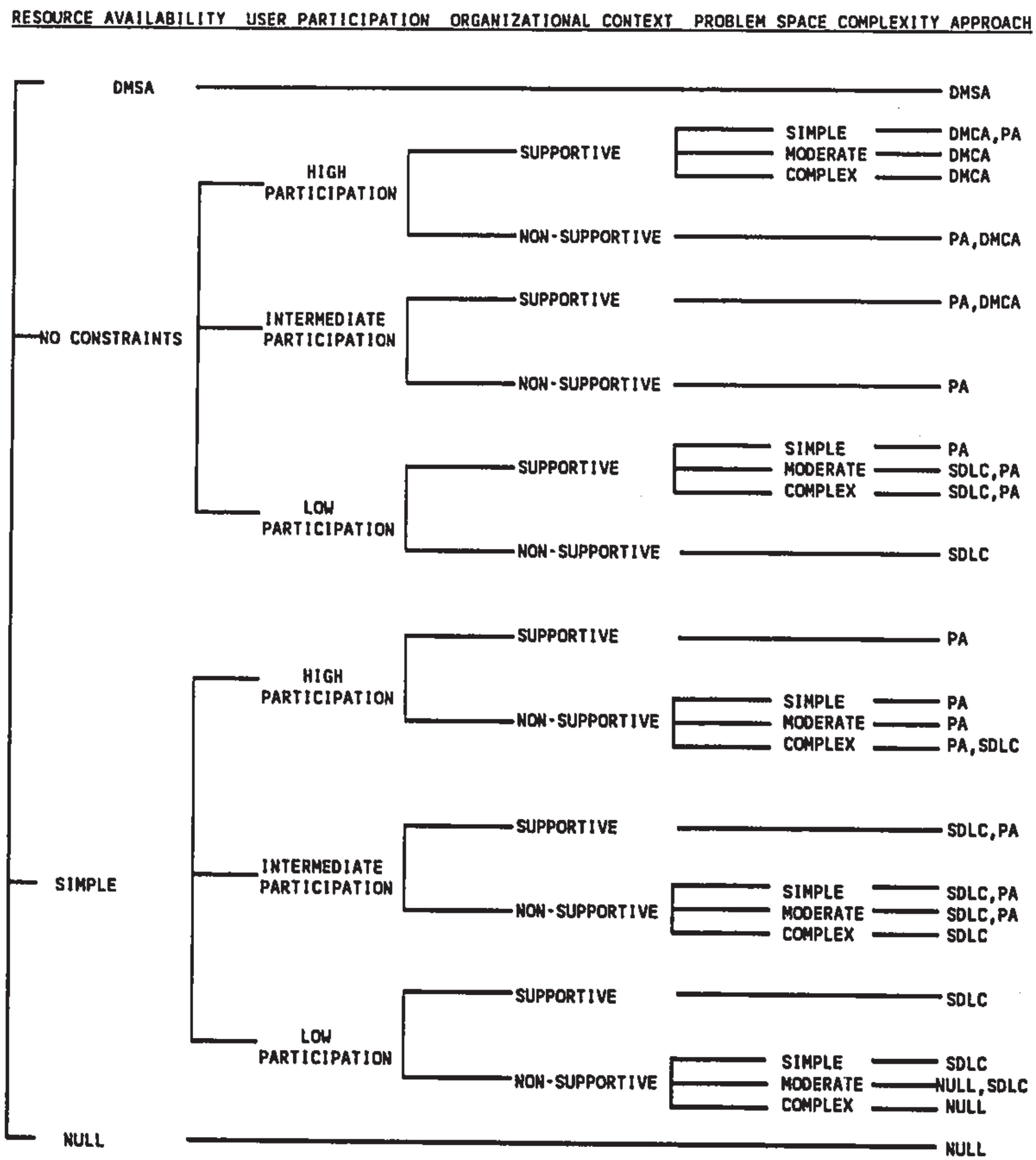
DECISION TREE FOR FACTOR III: RESOURCE AVAILABILITY

FIGURE VIII



DECISION TREE FOR FACTOR IV: ORGANIZATIONAL CONTEXT

FIGURE IX



DECISION TREE FOR THE FOUR FACTOR MODEL

FIGURE X

Similarly it may be possible to develop a more quantitative measure of factor values. As has been discussed in Chapter 4.2, it appears that each of the factors represents a single underlying construct. Implementations of the model should be based on this quantative factor value, rather than the qualitative factor value used in this initial study. This would eliminate problems such as what to do with the indeterminate situation in Factor IV, or how to handle borderline situations like situations 6 and 12 in Factor III.

Another area that should be examined is the use of a small discrete set of generalized systems development approaches. The model originally developed the attribute lists, based on the characteristics that many authors ascribed to systems designed to support decision makers. A logical expansion of the model would be to compile a list of systems attributes and systems development attributes. The model would suggest which sets of these characteristics would form the most appropriate approach(es) in a given situation. A tool with this facility would be more powerful and useful than the current model, and could be implemented no matter what set of system development approaches were in use in a particular organization.

Even given the need for refinement of the model it is instructive to look at model predictions for some sample situations. Consider the following situations where the value of Problem Space Complexity is Complex, and the value of Resource Availability is No_Constraints:

1) If the value of Organizational Context is Supportive, and the Value of Participation in the Decision Making Process is High the model suggests that a DMCA is appropriate. If one attempted to use a SDLC approach the most probable result would be a frustrated end user who would not be getting enough computer based support despite the availability of resources and the support of the organization for the use of I/S technology.

2) If the value of Organizational Context is Non-Supportive and the value of Participation in the Decision Making Process is Low the model suggests that a SDLC approach is appropriate. An attempt to use a DMCA would result in forced participation of a user who sees his role as hands off, and whose dissatisfaction would probably be magnified by the general negative attitude to I/S (non-suppportive organization context).

3) If the value of Organizational Context is Supportive, but the value of Participation in the Decision Making Process is Low the model is indifferent between the SDLC approach and PA. This suggests that a less complex decision making system would be more appropriate, given the lack of willingness of the end user to participate in the decision making process (ruling out DMCA) and the complexity of the problem space (ruling out DMSA). Although a PA would require more participation in the development by the end user than the SDLC approach, this might be offset by the improved quality of the resulting support system.

5.2.1 BACKTRACKING

Another method of improving the model for implementation would be to introduce some type of backtracking.

Although the model currently matches four sets of attribute levels to four factor values and then suggests which of the five approaches is preferred for this situation, it would be useful to be able to backtrack through the model. This would allow determination of which attributes are set at levels that appear to reduce the likelihood of successfully following a given preferred systems development approach.

One simple way of implementing backtracking would be to utilize the model in the form of an expert decision support system (EDSS). The model naturally lends itself to implementation as a rule based system, accepting as inputs the various attribute levels and providing a selected appropriate approach. However, it would not be suitable for implementation as an expert system, because of the complexity involved in backtracking, and the need for user input. Backtracking to determine how to improve the acceptability of another approach (which is preferred for political or practical reasons) could be implemented in an EDSS as follows :

1) Determine which of the factor values could be changed to alter the situation to one where the preferred approach would be the accepted approach. In general there will be many ways of doing this, and the decision maker could have these supplied to him by the system.

2) Have the decision maker decide which of the factor values he feels that it would be possible to change, and then provide the decision maker with all the possible sets of attribute levels changes that would make the necessary change(s) to the factor value(s).

3) Have the decision maker choose which of the sets of attribute level changes would be most easily implemented in order to change the factor value. If there were not a satisfactory way of changing the factor value(s), then the decision maker would go back to Step 1.

5.3 FUTURE RESEARCH AREAS

Today there is a great deal of interest in the study of how individual differences effect how individuals perceive their jobs and how well they perform in them. Indeed many people suggest that it is necessary to change the way we evaluate performance to take into account these individual differences. In the analysis of the final two phases of the research it was noted that individual differences were significant. The evidence supporting this included:

1) Multiple correlation coefficients were much smaller when the regression was done for the group overall, compared to the average of the individuals' regression coefficients. This was true for each factor, and especially significant for the overall model.

2) Verbal responses from many individual respondents indicated that they felt that there would be differences in responses from different types of individuals. Several respondents volunteered that an interesting extension of the research would be to try and determine: what were these differences, what were the size of the effects, and what implications did the existence of these differences have.

Specifically there are five areas of individual differences that would be of interest.

I) Many researchers believe that there is a perceptible difference in any academic discipline between work done with a feminist perspective, and that done from a male perspective. There have also been suggestions that aside from "political" considerations, there is a perceptible difference in how females approach research, management or professional activities compared to how males approach these activities.

II) The issue of risk aversion is important in the final phase of this research. During this phase subjects were asked what type of system they would implement under situations where there was a distinct difference in the overall level of organizational support for the development of the systems. Determination of the risk aversion characteristics of analysts could help in research into why systems development efforts fail.

III) There are differences in the backgrounds of senior systems analysts and managers in the MIS field. Many senior analysts have a "user background". Others have a technical/programming background. The effect of background on respondents could be studied.

IV) One could attempt a better determination of the different policies senior IS managers used in deciding which systems development approach to use. It would then be useful to see if these policies were in use in individual organizations, and to determine which of these policies is "optimal" in some sense.

V) Many authors suggest that organizations possess a culture, and that long term exposure to this culture would result in a change in the outlook and attitudes of individuals in different organizations. More subjects from organic organizations and highly bureaucratic organizations should be interviewed to determine the effects of organizational culture on the responses to both sets of questionnaires from the second phase.

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APPENDIX I

DELPHI TECHNIQUE

This normative group technique became increasingly popular as a method of defining group consensus in the late 1960's and early 1970's. A study done in the mid 1970's identified thousands of Delphi studies as opposed to hundreds which had been completed before 1970.

There are two general forms of Delphi, the traditional or "paper and pencil approach" , and a relatively new form, the Delphi Conference. In the more traditional method one starts with a small design team and designs an initial questionnaire which hopefully addresses the major issues on the topic under consideration. This is then sent to a larger group of experts whose responses are analyzed, summarized, and returned, along with a new questionnaire, and the summary. This new questionnaire includes issues which may have been overlooked by the initial design team. This second phase allows for the reaffirmation of individual responses in light of the group response to the initial questionnaire, as well as the presentation of the new issues.

The Delphi Conference utilizes computer networking to link together a group of experts in a real time session. The experts can respond to the initial questionnaire and their responses will be compared and analyzed on line by the computer system.

They can then respond to any new issues that are raised or change their responses based on the reported group response.This reduces the time commitment by the experts and the total cycle time of the process, but it is expensive and necessitates the creation of a computer network linking the experts, if one does not already exist.

Whichever form is chosen, the Delphi process consists of essentially four phases. 1) The initial exploration phase where the design team develops the first questionnaire. 2) The group review of the issues which includes summarization of the separate views.
3) Analysis of the differences presented by the group in their responses to the questions as well as an attempt at determining why these differences exist, rather than attempting to explain them away.
4) Re-evaluation of the new questionnaire and the summarized data by the expert panel and the summarization of these results. The last two steps are repeated until a consensus is achieved, which usually takes at least three rounds of the exercise.

As in any attempt to sample opinion or obtain consensus there are problems to overcome. The first is an expert panel appropriate? The next is similar to that faced by most group techniques, how to select the group of experts. From the extensive use of the technique in the field of technological forecasting, it appears that it is accepted to use an expert panel (if not necessary) to attempt to forecast future developments in technology [Dickson 1984], [Irvine and Martin 1984].

Since what we are attempting to do is determine a definition of technical concepts, with a view towards the future uses of these concepts, it would appear that we are using this technique under appropriate circumstances. The selection of members of the panel is still an art rather than a science, but given the scarcity of experts in the field, it will not be difficult to obtain a representative sample, if enough members of this elite group agree to participate.

Some of the problems specified to the technique itself include:

-imposing the view of the design team of the panel (this can be dome by overspecification in the questionnaire)

-poor summarizing or presentation of the results to the expert panel, resulting in a poor product or in the need for additional iterations

-ignoring the differences in responses in an attempt to arrive at a consensus, which can prejudice the results.

For a Delphi study to reach convergence in a small, fixed number of rounds, it is necessary that the initial input be as "good" as possible, and that the task be as simple as possible. The convergence process in the Delphi study is iterative and, like iterative processes in numerical analysis, if the initial estimate is "close" to the optimal solution then there is a better chance of reaching that optimal solution. Assuming that the optimal solution will be found, in general it will take fewer iterations to reach it. This is because if the initial model is "far" from optimal, the expert panel may:

1) find it difficult to understand the task (and either drop out of the study or produce incorrect responses),
2) individually focus on one aspect of the problem that appears faulty, so that there will be major changes from round to round in the initial rounds of the study, before they can begin to agree on the model structure.

As with most problems in data analysis, awareness of the possible problems is half the battle in overcoming their possible effects. The other half will be greatly aide by the presence of an interested and supportive committee.

APPENDIX II

INSTRUMENTS FROM THE FIRST AND SECOND ROUNDS OF THE DELPHI

Royal Military College of Canada
Kingston, Ontario
K7K 5L0

May 15, 1987

Dr. John Doe
Department of Decision Sciences and Information Systems
Florida International University
Tamiami Trail
Miami, Florida
33199

Dear Sir :

I would like to thank you for having agreed to participate in this Delphi study. As you know, a Delphi study is a technique for obtaining a consensus from a group of experts. The panel members were chosen because of their expertise in various areas of the MIS discipline.

You will be asked to evaluate a model for selecting which of a set of generic system types would be most appropriate for aiding a decision maker in a given situation. The model describes situations in terms of three factors, each of which is defined in terms of a set of attributes. The three factors are:

(1) User Involvement (in the decision making process)
(2) Problem Space
(3) Resource Availability

The model assumes that situations can be defined in terms of a limited set of attributes for each of these factors. The resulting set of unique situations can then be related to different tools for supporting decision makers.

Page one of the supporting documentation is a description of the different generic system types. Page two provides a list of the factors and their attributes. Pages 16 to 25 provide a description of the attributes and how the decision rules operate. The last four pages show the pruned decision trees which are used in combining the rules.

You will be asked to perform two related tasks in evaluating the model. The first is to evaluate the structure of the model. You will be asked to rate each factor on a scale from important to unimportant in defining various situations. If you feel that any significant factors have been omitted please list them in the space provided. You are also asked to rate the set of attributes defined for each factor. If there are additional attributes which you feel are important in describing this factor, please list them in the space provided. You are also given the chance to note if any of the attributes should be associated with a different factor.

The second task is to evaluate a suggested implementation of the model. Each factor can take on a number of different values based on the values of the various attributes associated with it. The model has a set of rules which match various combinations of attribute values to factor values. Similarly the model provides a set of rules which detail how various factor values can be associated with situations which favour certain support system types. The rules first allow a significant pruning of the decision trees (see the last four pages of the

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supporting documentation), and also the rational for selecting a system for use in a particular situation.

The rules used in this process are to be evaluated on an agree/disagree scale. If you disagree with a rule, a space is provided where you may list the reasons why you disagree.

One round in the process consists of sending out the instrument to the panel, and tabulating the results and producing a modified instrument to return to the panel. After each round you will receive the tabulated responses from the whole panel as well as all of the panel's comments and suggestions. You will then be asked to complete a similar form evaluating the structure and function of the modified model. If there appears to be a consensus from the panel about any suggested changes after any round these will be added to the model. This process will continue until a consensus is reached. A consensus will usually develop within three or four rounds.

If you have any further questions I can be reached at

Royal Military College of Canada
Kingston, Ontario, Canada
K7K 5L0
613-545-7355
613-545-7359 (departmental secretary)

or my supervisor Dr. Archer can be reached at
McMaster University
Hamilton, Ontario, Canada
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416-525-9140 ext. 3944

Yours Truly

T. Dececchi

Canada

Definitions of the Generalized Approaches to Supporting Decision Makers

Null Approach (NA) -

No computer support.

System Development Life Cycle Approach (SDLC)

An information system that provides the users with information, but little aid in analysis. It is developed using a systems life cycle approach, with analysis, design and implementation phases and with user participation in the process. The system focus is on collecting, organizing, storing and retrieving information. May have query facilities to allow for ad hoc requests or provision of new reports based on existing data.

Prototyping Approach (PA)

An information system that provides the users with information, but little aid in analysis. It differs from the SDLC in that it is developed in a recursive fashion, where the system is continuously growing and developing from an initially simple start utilizing continuous feedback from the users. It performs the same functions as the SDLC type system.

Decision Maker Centered Approach (DMCA)

The system which is designed to provide user support in all phases of the decision making process, providing the user with access to information, analysis tools and reporting facilities. It is developed in an evolutionary, participative fashion, with the end user.

Decision Making System Approach (DMSA)

A decision making system which will produce a suggested decision for a decision ratifier. It will be developed in a participative evolutionary fashion with an expert, not the end user.

List of Proposed Factors and Attributes

ATTRIBUTE	VALUES
User Involvement Factor	High, Indeterminate, Low.
(1) Decision Maker or Ratifier	Decision Maker, Decision Ratifier.
(2) Degree of User Participation	Solicited-High Participation, Solicited-Low Participation, Unsolicited-High Participation, Unsolicited-Low Participation.
(3) User Cognitive Style	Analytic, Heuristic.
(4) Degree of User Discretion	Discretionary, Forced Use.
(5) User Decision Making Style	Autocratic, Consultative, Group.
(6) Organizational D/M Style	Socio-Political, Programmed/Bureaucratic.
Problem Space Factor	Complex, Moderate, Simple.
(1) Problem Uniqueness	Non-recurrent, Repetitive.
(2) Problem Set Definition	Multiple Problem Sets, Single Problem Set.
(3) Data Resource Specification	Simple Data Resources, Complex Data Resources.
(4) Range of Problems	Wide Range of Problems, Narrow Range of Problems.
(5) Problem Type	Amenable to Heuristic Search, Amenable to Analytical Solution.
(6) Interdependence of Decisions	Pooled, Sequential, Reciprocal.
(7) Problem Structure	Unstructured, Semi-Structured, Structured.
Resource Availability Factor	Null, Simple, No Constraints, DMSA.
(1) Availability of Human Expertise	Available, Unavailable.
(2) User/Developer Task Comprehension	High, Indeterminate, Low.
(3) Availability of Technology	Available, Unavailable.
(4) Availability of Time To Develop Specific Systems	No Time Constraints, Time Constraints.
(5) Availability of Personnel To Develop Specific Systems	Development Staff Available, Low Staff Availability.

PART ONE

VALIDATION OF THE MODEL STRUCTURE

In this section you are asked to rate each factor and each attribute. The first scale is a five point likert like scale for rating the importance of each construct. The scale ratings range from unnecessary through indeterminate (not clearly necessary or unnecessary) to very necessary. You are also asked if the attribute is a good descriptor of the factor to which it has been assigned, or if it is could be more appropriately assigned to another factor. The factors and their attributes are described in detail in the supporting documentation.

Factor I: USER INVOLVEMENT IN THE DECISION MAKING PROCESS

This factor is:

Unnecessary | Indeterminate | Very Necessary

The following is a list of the attributes which are used to describe the User Involvement factor. Descriptions are on pages 16 to 20 of the supporting documentation.

(1) The need for a decision maker or a decision ratifier.

Unnecessary | Indeterminate | Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated ?

(i)Problem Space [ ] (ii) Resource Availability [ ]
(iii)Other (please specify)

(2) Need for user participation in systems development.

Unnecessary | Indeterminate | Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)Problem Space [ ] (ii) Resource Availability [ ]
(iii)Other (please specify)

(3) User Cognitive Style

Unnecessary — Indeterminate — Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)Problem Space [ ]   (ii) Resource Availability [ ]
(iii)Other (please specify)

(4) Degree of User Discretion

Unnecessary — Indeterminate — Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)Problem Space [ ]   (ii) Resource Availability [ ]
(iii)Other (please specify)

(5) User Decision Making Style

Unnecessary — Indeterminate — Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)Problem Space [ ]   (ii) Resource Availability [ ]
(iii)Other (please specify)

(6) Organizational Decision Making Style

Unnecessary — Indeterminate — Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)Problem Space [ ]   (ii) Resource Availability [ ]
(iii)Other (please specify)

Please list any additional attributes that you feel are important in the evaluation of this factor and the range of attribute values that you feel are proper.

Factor II: PROBLEM SPACE

This factor is .

Unnecessary Indeterminate Very Necessary

The following is a list of attributes which are used to describe the Problem Space factor. Descriptions are on pages 21 to 23.

(1) Problem Uniqueness

Unnecessary Indeterminate Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(I)User Involvement [ ] (II) Resource Availability [ ]
(III)Other (please specify)

(2) Problem Set Definition

Unnecessary Indeterminate Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(I)User Involvement [ ] (II) Resource Availability [ ]
(III)Other (please specify)

(3) Data Resource Specification

Unnecessary Indeterminate Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(I)User Involvement [ ] (II) Resource Availability [ ]
(III)Other (please specify)

(4) Range of Problems

Unnecessary Indeterminate Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(I)User Involvement [ ] (II) Resource Availability [ ]
(III)Other (please specify)

(5) Problem Type

Unnecessary Indeterminate Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)User Involvement [ ] (ii) Resource Availability [ ]
(iii)Other (please specify)

(6) Interdependence of Decisions

Unnecessary Indeterminate Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)User Involvement [ ] (ii) Resource Availability [ ]
(iii)Other (please specify)

(7) Problem Structure

Unnecessary Indeterminate Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)User Involvement [ ] (ii) Resource Availability [ ]
(iii)Other (please specify)

Please list any additional attributes that you feel are important in the evaluation of this factor and the range of attribute values that you feel are proper.

Factor III: RESOURCE AVAILABILITY

This factor is:

Unnecessary | | Indeterminate | | Very Necessary

The following is a list of attributes which are used to describe the Resource Availability factor. Descriptions are on pages 24 and 25.

(1) Availability of Human Expertise

Unnecessary | | Indeterminate | | Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(I)User Involvement [ ] (II) Problem Space [ ]
(III)Other (please specify)

(2) User/Developer Task Comprehension

Unnecessary | | Indeterminate | | Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(I)User Involvement [ ] (II) Problem Space [ ]
(III)Other (please specify)

(3) Availability of Technology

Unnecessary | | Indeterminate | | Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(I)User Involvement [ ] (II) Problem Space [ ]
(III)Other (please specify)

(4) Availability of Time to Develop Specific Systems

Unnecessary		Indeterminate		Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?
(i)User Involvement [ ]   (ii) Problem Space [ ]
(iii)Other (please specify)

(5) Availability of Systems Personnel to Develop Specific Systems

Unnecessary		Indeterminate		Very Necessary

If you feel that this attribute is necessary, but it is not part of this factor with which factor should it be associated?

(i)User Involvement [ ]   (ii) Problem Space [ ]
(iii)Other (please specify)

Please list any additional attributes that you feel are important in the evaluation of this factor and the range of attribute values that you feel are proper.

Please list any additional factors that you feel should be included in the model and any attributes that you feel describe these factors.

Part II

VALIDATION OF THE RULES

In this section the user will be asked to validate the rules used for both pruning the decision trees and for evaluating the end states. You will be asked to respond using a 5 point Likert like scale with values ranging from strongly disagree, to indeterminate (neither agree or disagree) to strongly agree. Please refer to the supporting documentation (pages 16 -25) for descriptions of the attributes and the rules, and to the last four pages for the pruned decision trees themselves.

Factor I : USER INVOLVEMENT IN THE DECISION MAKING PROCESS

The rules for this factor are described in detail in the supporting documentation pages 16 to 20.

(a) A user who is willing to become a decision ratifier has a low need to become involved in the decision making process.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(b) A decision maker who has actively solicited the system and has a high need to participate in the development of the system (as defined in the supporting documentation) is likely to be highly involved in the decision making process.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(c) Decision makers whose problem solving style can be described as analytic will tend to be more involved in the decision making process than those whose style could be described as heuristic, all other things being equal.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(d) All other things being equal a discretionary user will be more involved in the decision making process than one who is forced to use the support system.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(e) Users in group decision making situations will generally need to be highly involved in the decision making process.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(f) Organizational decision making styles that can be classified as socio-political require the decision maker to be more involved in the decision making process than those which could be classified as programmed or bureaucratic.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

Factor II: PROBLEM SPACE

The rules that describe the Problem Space factor are described in the supporting documentation pages 21 to 23.

(g) If it is probable that the decision maker will be faced with problems that can be described as unique or non-recurrent then the problem space can be considered to be complex, from the perspective of having to develop a support system.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(h) If the system has to provide support in an environment with multiple problem sets (e. g. a combination of finance, marketing, personnel etc. as opposed to a single area) then the problem space can be considered to be complex regardless of whether or not the problems are interdependent.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(i) If the users of the system require multiple data resources or data resources which can't be fully specified during system development then the problem space is considered to be complex.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(j) If a wide range of problem solving (within a single problem set) needs to be supported, the problem space is more complex than if the feasible set of problems is narrowly defined.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(k) If the problem space consists of problems that require the use of various analytical tools it will be considered more complex than one where the problems can be solved heuristically (see supporting documentation for discussion).

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(l) If the decision making process is part of a more highly interrelated overall decision making process then the problem space can be considered to be more complex than if the decision making process were more isolated.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(m) If the problem space consists primarily of problems which are unstructured it can be considered to be more complex than one where the problems are partially structured. Similarly, a problem space in which the problems are partially structured is more complex than one where the problems are well structured.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

Factor III:RESOURCE AVAILABILITY

The rules that describe the Resource Availability factor are described in detail on pages 24 and 25.

(n) If there is no problem domain specific human decision making expertise available then the system must supply the expertise (if this is possible).

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(o) The higher the level of user developer task comprehension (where the task referred to is the development of a support system) the lower the level of uncertainty in developing the system, hence the more complexity can be built into the system.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(p) The greater the availability of software (primarily) or technology in general for a given system, the greater the level of complexity that can be built into the system.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(q) Time constraints will tend to lower the amount of complexity that can be built into the system. In general simpler systems can be supplied more quickly then more complex ones.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(r) Increased levels of support staff availability (for the development of individual systems) means that more complex or specialized systems can be provided.

Strongly Disagree		Indeterminate		Strongly Agree

Comments:

(1) The more complex the problem, the more human involvement will be necessary in the decision making process, or the more complex the support system which must be provided, all other things being equal.

Decision Making Systems are more complex systems than Decision Maker Centered Systems which are in turn more complex systems then Organizational Information Systems for solving the same problem.

Strongly Disagree | Indeterminate | Strongly Agree

(2) Strategies which provide for evolutionary systems development with the end user are preferred in situations where high user involvement in the decision making process is necessary. In situations where evolutionary development is necessary we can define these partial orderings :

A Decision Maker Centered Approach is preferred to a Decision Making Systems Approach

and

A Prototyping Approach is preferred to a Systems Life Cycle Approach

Strongly Disagree | Indeterminate | Strongly Agree

(3) The more severe the resource restrictions (with the exception of situations covered by (1) above), the less complex support system that can be provided, all other things being equal.

Strongly Disagree | Indeterminate | Strongly Agree

(4) The less the restrictions on resources, the more complex the system provided could be. It is assumed that the highest level of support possible should be provided to decision makers, given the available resources.

Strongly. Disagree | Indeterminate | Strongly Agree

SUPPORTING DOCUMENTATION

I. User Involvement

The user involvement factor is operationalized as having three levels: low, indeterminate and high. The decision tree which shows which of the various combinations of the variables correspond to these three levels is at the end of this section. There are two types of attributes in this factor, those which deal with the users wants or needs and those which deal with situational dictates or what should be done in this situation.

(a) Need for a Decision Maker or Decision Ratifier

Early definitions of DSS stressed their role in supporting rather than replacing decision makers [Alter 1980], [Keen and Scott Morton 1978], [Ginzberg and Stohr 1981]. Lee [1982] differentiated between expert systems which seek to replace the decision maker with a decision ratifier and DSS which support the decision maker. Others, however describe how DSS and ES can be merged in Expert Support Systems [Turban and Watkins 1986], [King 1986],[Fordyce 1986].

We must be careful to differentiate between those approaches which make use of AI technology to support (as advisors) and those which attempt to use it to replace (or substitute for) the decision maker [Adler 1984]. In doing this we have defined a system (DMS) which replaces the human decision maker with a decision ratifier whose function is to accept or reject the computer generated solution (as did Lee [1982]). This is similar to the Ginzberg and Stohr [1981] definition of top managers as decision ratifiers who accept or reject the decisions of their subordinates without becoming involved in the decision making process. We have also defined three other systems where the the user must fill the role of decision maker with more or less support from the computer.

If the model suggests that a Decision Making Systems Approach is appropriate it is suggesting that the proper role for the user is that of a decision ratifier. In all other situations the user must remain a decision maker.

The attribute described here defines whether or not the end user chooses or accepts the role of decision ratifier as opposed to decision maker. Adler [1984] suggests that one of the major problems with commercializing medical diagnostic expert systems is that doctors (like most other professionals) will accept computer based advisors, but not substitutes. They will continue to insist on remaining part of the decision making process, although they are willing to accept computer based support. If the user has enough discretion to accept or reject redefinition of his role, then he must accept this redefinition to decision ratifier if a DMS is to be successfully implemented.

Whether or not the user has this discretion, if their role is defined as one of decision ratifier then by definition they will have little or no involvement in the decision making process.

(b) User Participation in Systems Development

There are two dimensions of this attribute, whether or not the user has solicited the system, and whether or not the user has a high need to participate in the development process.

Sprague and Carlsen [1982] suggest that a user who has solicited or initiated the systems development effort has more of a stake in the success of the system. Similarly Mahmood et al [1983] quote from Alter [1980] to show that DSS are more likely to be successful if they are solicited by either the user or top level management and that successful implementation is easier if the user has solicited the system. Their reasoning includes the fact that in the case of the user soliciting the system they will have enough of an understanding of the problem space to have identified the need for a system.

We must look at the involvement process itself to understand the level of user participation. Debrabander and Edstrom [1977] and Debrabander and Thiers [1982] suggest that the type of interactions between the user and the systems developers can be related to systems success. If the user is forced into sham participation then it may be worse than no participation at all, in that the probability that they will use the system is limited. Debrabander and Edstrom also suggest that effective communication will be defined differently in different situations. Similarly Oppelland and Kolf [1981] have defined different levels of user participation as being appropriate in different situations.

In a paper comparing Institutional and Ad Hoc DSS Donovan and Madnick [1978] describe institutional DSS as supporting a narrow range of users, and a narrow range of decisions. They need to be supplied with data in advance, support few decision types and a large number of people. Turban and Watson [1986] in comparing ES and DSS note that ES operate on a narrow problem range and solve repetitive problems. Our definition of DMS specifies that they need to be supplied with an initial database and suggests service to a great many users in similar situations. It would appear therefore that there are similarities between Institutional DSS (as defined by Donovan and Madnick) and ES (as defined by Turban and Watson) and our definition of DMS.

One key "physiological" similarity is that all have to some extent reduced the participation of their users in the decision making process. Institutional DSS do this by reducing the discretion of their users by selecting the methods and/or the tools for solving the problems as well as the data that will be used to solve the problems. ES (as defined by Turban and Watson [1986]) could still allow the user some role in the decision making process but it would appear that much of the process has been automated. DMS carry this to the extreme by completely automating and controlling the Decision Making Process. This corresponds to the relationship between system type, user role and the need for user participation (and could explain the results of Mann and Watson [1984] who appear to be describing an Institutional DSS).

We will postulate that the need for the user to participate in the development of the system is related to their participation in the decision making process itself. This variable will then be operationalized as the following four values :

Solicited - High user need to participate in development
Solicited - Low user need to participate in development
Unsolicited - High user need to participate in development
Unsolicited - Low user need to participate in development

The user who has solicited a system and has a high need to participate in the development of the support system is assumed to have a strong need to be involved in the decision making process. The user who is being provided with a system and has little need to participate in the development of the system is assumed to have little need to participate in the decision making process. The other two cases are considered intermediate between these extremes.

(c) Cognitive Style

This variable effects the situation in two ways. If we accept the views of some authors then we should attempt to match the users cognitive style to that of the support system. Similarly there are classes of problems which lend themselves to either analytic or heuristic types of problem solving techniques. This attribute will consider the users cognitive style. Also it will consider the users involvement in the entire decision making process, including analysis, design and choice phases, not only at the choice phase of the decision making process

There is evidence that users with different cognitive styles solve problems in different fashions and therefore require different types of support. One example of this is the tendency of engineering managers (who have a highly analytical cognitive style) to focus on numerical data, and to have a tendency to "work things out for themselves". Lucas [1978] suggests something similar in that quantitative individuals make less use of the output from interactive planning systems then do heuristic individuals, possibly because they have less faith in the output from such systems. This attribute is operationalized as a dichotomous variable with values heuristic approach and analytic approach.

In this model we are assuming that users whose cognitive style is analytic will generally have stronger desire to work through problems themselves, whereas those whose cognitive style is more heuristic won't, all other things being equal. Therefor users whose style can be described as analytic will be more involved in the decision making process.

(d) User Discretion

This attribute is closely related to attribute (a). Whether or not a user will accept or reject a given role depends on the amount of discretion they have. However the amount of discretion that the user has may effect strategy selection beyond whether or not they will accept a role as a Decision Maker or a Decision Ratifier.

If we consider the situation where the user is left in the role of decision maker they may have considerable discretion over whether or not they will use the system in a given situation. Methlie [1983] states that many users of DSS have considerable discretion over how and when they will perform a specific task and a choice as to the tools that they will use. Young [1983] also states that the managerial user will retain control over the task and outcome and Lucas [1978] suggests that DSS users have more discretion than other system users.

We will operationalize this concept as a dichotomous variable with values discretionary and forced use. A discretionary user would be able to choose not only the type of support system, but the method used to solve the problem, the data needed etc. A forced user of the system would be less involved in the decision making process to the extent that at least some parts of that process are beyond their control (i.e. whether or not to use computerized support).

<u>A highly discretionary user will be more involved in the decision making process itself than a forced user would be, all other things being equal.</u>

(e) User Decision Making Style

The Vroom-Yetton [Vroom 1973] model describes five different decision making styles in three "classes". For our purposes we can use the three classes of styles. The first consists of AI or AII styles (autocratic decision making). The second consists of CI and CII styles (a consultative approach to decision making that still leaves one individual in charge). The last would be GII which represents true group decision making.

In situations which could be described as autocratic, where the decision making is done by a single individual it is possible that one could remove the user from the decision making process by making them a decision ratifier, allowing the system to make the decisions, all other things being equal.

In situations where there is some need for group involvement in the form of consultation (usually because several types of expertise or sources of data are needed) the user would probably be more involved in the decision making process. This is because humans tend to be more flexible [Robey 1983] and better able to handle multiple inputs then computers are [Turban and Watson 1986].

By definition situations which require GII decision making styles require some form of group consensus, meaning that those affected by the decision must be involved in the decision making process.

If the the user decision making style can be described as GII, the user involvement in the decision making process can be described as high. Consultative styles will be associated with equal to or higher levels of user involvement than autocratic styles, depending on the values of the other attributes in this factor, and they will in turn be equal to or lower than levels associated with GII styles.

(f) Organizational Decision Making Style

This attribute can be operationalized in terms of four styles as described by Huber [1981] or five as described by Keen and Scott Morton [1978]. For our purposes we will define two dichotomous styles based on these definitions:

If the organization has chosen to combat environmental uncertainty [Galbraith 1974] by developing standard operating rules or procedures for decision making, or if the organization has a rational form of decision making with well defined and coordinated goals and objectives then the user will be less involved in the decision making process to some extent, all other things being equal. This is because the "rules" have already been made so in a sense there are no decisions to make, only policies to enforce. The decision maker serves more as a decision ratifier, intervening only in exceptional circumstances where the rules may not apply.

If the organization has chosen to combat the environmental uncertainty by developing expertise among its human decision makers or if it presents an environment where decisions are made on social or political considerations (Socio-political) the decision maker will be highly involved in the decision making process, all other things being equal. There are two possible reasons for this.

(1) These situations are difficult to structure a priori, lessening the use of the computer as a decision making tool (according to most writers of DSS who have made use of the Gorry and Scott Morton framework).

(2) There exists a need for local expertise, that is the special situation dependent knowledge that only someone in the organization can possess.

(1) Bureaucratic, programmed or rational decision making styles help define a situation where there is less need for user involvement in the decision making process, all other things being equal.

(2) Socio-political, or other styles which emphasize user initiative and the need for unique responses would make systems which give the user a greater role in the process more appropriate,all other things being equal.

II. PROBLEM SPACE FACTOR

This factor is operationalized in three levels, complex,moderate and simple. It is assumed that problems that can be defined as more complex will help define situations that are more amenable to systems that make more use of the human decision maker in their solution. The decision tree for this factor is in given at the end of the supporting documentation.

(g) Recurrency

There are two considerations here. The first is whether the problems are unique or ad hoc, or whether they are recurring. The second is whether they are unique to one user or found organization wide. Many authors have stated that ES are only appropriate in situations where problems are recurrent [R.Davis 1983], [Turban and Watson 1986] etc. This is similar to Institutional DSS [Donovan and Madnick 1977] as compared to Ad Hoc DSS. If the computer system must be designed to take over more of the Decision Making process, then it will be more complex, more expensive and there will be less of a payback situations of limited use. In the extreme case it is difficult to see how one can justify using an expert to develop a system to mimic his or her judgment, then test the system with the expert on realistic test cases, if the problem itself is unique and will only need to be solved once. On the other hand there are many cases where DSS have been developed for a single application.

We will operationalize this variable in a dichotomous fashion. One value will be "non-recurrent" and it will be taken to mean that the problem is either one of a kind or found sufficiently rarely in the organization as a whole so that it can be taken as unique. The other value, representing problems that occur more frequently, will be labeled "repetitive".

If the majority of problems or probable problems in the problem space can be described as unique or non-recurrent then the problem space will be assumed to be complex.

(h) Problem Set Definition

Turban and Watson [1986] in comparing ES and DSS suggest that ES are more suitable for a narrow domain and DSS for a wider problem domain. ES performance in general "degrades rapidly" outside a narrow area of expertise [R.Davis 1984]. Donovan and Madnick [1977] in their comparison show Ad Hoc DSS more appropriate for situations where there is a wider problem domain then Institutional DSS. It appears that the more of the decision making process that is automated, the less flexible the system. From a systems development point of view, the need to handle more then one problem set would create a more complex problem space in that it would take a more sophisticated system to deal with this variety.

This variable is operationalized as either Multiple Problem Sets or a Single Problem Set.

If the problem space contains more than one problem set, than the problem space factor will be assumed to be complex.

(i) Data Resource Specification

This attribute represents the complexity of data resources required by a particular problem, so it is an attribute in the problem space attributes factor rather than one in the resources factor. This attribute will be operationalized as either simple or multiple. A problem space requiring simple data resources is one where the data can be prespecified or at least access to the data can be prespecified in some sense. A problem space requiring complex data resources is one where the data required to solve the problem (and the source of that data) cannot be specified a priori. This is based on the Donovan and Madnick [1977] comparison of Institutional and Ad Hoc DSS and the problems other researchers have reported in connecting ES to multiple data sources. It would appear that the greater the number of sources the more complex the problem of designing a system to access these sources, especially if there is no certainty over which sources should be used.

A problem space requiring complex data resources will be assumed to be complex because of the difficulty of handling these situations.

(j) Range of Problems... Evolution in Use

Even if a problem space can be said to encompass only one type of problem (one problem set) one may still be able define a range of problems within the problem set. This is especially true in the case where the system is expected to grow and develop with the user.

Unless the support system can be "fully developed" initially, to provide support for the entire range of problems within a problem set (which evolutionary proponents of DSS argue may neither be possible nor desirable) it must be able to grow with the user. R.Davis [1984] suggests that in the future expert systems may be able to learn, although none can today. However even if they do develop some improvement capabilities this will most likely be limited to improving probability estimates used in diagnostic systems or optimizing programme efficiency rather than expanding the range of problems that they can solve [Hayes-Roth 1983].

This variable will be operationalized as a dichotomous variable with values narrow and wide. If there is a narrow range of possible problems in the problem space then one may be able to design a system to support a decision maker in the majority of probable situations. However if there is a wide range of problems in the problem space then it is more likely that the system will have to evolve over time to meet the users specific needs.

The ability to evolve requires a flexible system and therefore situations which need this ability represent a more complex problem space, all other things being equal.

(k) Problem Type

This attribute represents the need to use different problem solving styles as opposed to the users personal cognitive style. It is based on the assumption that there are certain problems or classes of problems that lend themselves more naturally to an analytic approach as opposed to those which can be solved heuristically [Hale 1986], [Benson 1986].

The major problem with developing DMS in the analytic domain is this need to use/develop two types of systems; the actual analytical tools, and the intelligence to use these tools. Today there are many powerful analytical tools available for use by people who are not experts in OR. The intelligence has been implicitly buried in the tool itself with AI techniques being used to "sugar-coat" these tools by providing natural language interfaces and more sophisticated computer based aids for using them. While the user may require some training or help to make proper use of these tools, they need not be an expert to use them. These individuals are not experts, yet the difficulty of developing a decision making system to replace them would be as difficult as developing an expert replacing system. (consider the case of an expert system developed at ICC [M. J. Keen 1986] which took 30-35 weeks to develop, and most of the rules involved using an existing queuing model written in Pascal.)

The human user will have some problem domain knowledge, as well as some knowledge on how to use the various analytical tools. Supplying the user with these powerful tools allows the user to function much more effectively, and in general takes advantage of the flexibility of the human user. In general this user rarely possesses "rare expertise" worth cloning.

From a systems development perspective, all other things being equal, a problem space composed of problems for which heuristic approaches are preferred will be assumed to be less complex than one for which problems require the use of both heuristics and analytical techniques.

(I) Interdependence of Decisions

This attribute can be operationalized in terms of a three valued taxonomy [Thompson 1967]. Pooled refers to decisions which are basically independent. Sequential to systems in which decisions are made one based on the previous one in a linear fashion. Reciprocal refers to decision making processes where decisions from one decision maker effect those made by another, and in turn those decisions may effect the decisions made by the first decision maker, in a type of feedback process. Basic systems theory [Davis 1984] tells us that if we can break a system into a set of minimally interacting subsystems, the job of design and maintenance of that set of smaller systems will be simpler than the job of designing and maintaining a single larger system of comparable size. The more interaction between decision makers (human or automated), the less independent the decision making subsystems are and the more complicated the task of designing support for them.

In situations of reciprocal decision making where there is significant interaction between decision makers the problem space can be considered as more complex, all other things being equal.

(m) Problem Structure

This attribute will be operationalized using the Simon taxonomy of structured, semi-structured and unstructured problems. It is assumed that it may be possible to specify at the time of system development some idea of the degree of structure the problems will possess. This is not to say that the problems cannot be broken down into structured and less structured segments, but that this cannot be done a priori. The concept that it is a more difficult task to support users in a less structured problem space is rooted in much of the DSS literature [Scott Morton 1971], [Alter 1980].

A problem space which is composed of problems that can generally be defined as unstructured is assumed to be more complex than one where the problems are partially structured. A problem space where the problems are partially structured is assumed to be more complex than one where the problems are structured.

III. RESOURCE AVAILABILITY

This section will discuss the resource availability factor. This factor will be assigned four values representing points on a scale from no support possible (null), through restricted support possible (simple), to no restrictions on the support available, to the need for computer controlled decision making (DMSA necessary). The decision tree is found at the end of the supporting documentation.

Null-------------	Implies that it will not be possible to provide computerized support due to the lack of resources.
Simple System----	This means that the availability of resources will force the choice of more basic support systems. This will mean different things in conjunction with combinations of the other factors.
No Constraints---	This means that resources will not constrain the choice of strategy as suggested by the other factors.
DMSA-------------	Implies that it will be necessary to supply a Decision Making System due to the lack of available, problem specific, human expertise.

(n) Human Expertise

This attribute is meant to represent whether or not a capable human decision maker exists in the situation. If not then it will be necessary to supply a computerized decision maker. One of the arguments behind research to develop expert systems has been the scarcity of human expertise in certain fields and therefore the need to "clone" this expertise [Whinston 1984]. It is operationalized as a dichotomous variable with values Available and Unavailable.

If no suitable human decision maker exists than a DMS is assumed to be the only viable alternative.

(o) User/Developer Task Comprehension

The higher the level of task comprehension by both the user and the developer the greater the probability that the system can be prespecified [Davis 1982]. If the opposite is true than the system will most likely need to undergo some form of evolutionary development. This variable is operationalized as three values:

High ------------	Both the user and the developer have a good understanding of what is needed.
Indeterminate ----	Either the user or the developer has a poor understanding of what is needed.
Low -------------	Both the developer and the user have poor understanding of what is needed.

The lower the level of user developer uncertainty, the more complexity can be built into the system

(p) Technology Availability (At A Cost Beneficial Price)

Operationalized as either appropriate technology being available for a specific project or unavailable. Note that although the appropriate software might exist it may be too expensive for use in a particular situation. I.E. a framework package may exist that is suited for one particular application but it would require the purchase of specific hardware so that the total cost would be prohibitive. Or there may not be appropriate commercial software available for a particular application so that the system would need to be developed from low level tools (Prolog, Lisp, a DBMS, a procedural language etc.) which would increase the cost and time required to develop the system.

All other things being equal the lack of appropriate technology will be assumed to lessen the probability that a more complex system can be developed.

(q) Time Constraints (For the Development of Specific Systems)

This attribute represents whether or not the time to develop a system is a major constraint. It is operationalized as no time constraints and time constraints. Donovan and Madnick [1977] suggest that Ad Hoc DSS (which leave more of the Problem Processing with the user) are more appropriate (or realizable) than Institutional DSS in situations where time is critical. Similarly unless there are existing ES available, it would appear [Hayes-Roth et al 1983], [R. Davis 1984] that it takes a considerable amount of time to develop a DMS. Also Mahmood et al [1983] suggest that if the time frame is short term normally some form of crash design be used. This would appear to suggest that if there are major time constraints then one would need to rely more on the user and less on the system, because less of a system could be developed.

All other things being equal the less time available for system development, the simpler the final system will be.

(r) Availability of Development Staff To Develop Specific Systems

This attribute measures whether or not there are sufficient support staff to provide aid to develop individual systems. It will be operationalized as Development Staff Available and Low Availability.

All other things being equal it will be assumed that the lower the support staff availability for the development of individual systems, the simpler these systems will be, or that the availability of support staff for the development of individual systems will allow more complex systems to be built.

Dr. J. Doe

Faculty of Business

McMaster University

Hamilton, Ontario

March 8,1988

Dr. Doe :

I would like to thank you for your continued participation in this Delphi Study. In Appendix I of the supporting documentation you will find a summary of the results and a list of the comments generated in the second round.

For this round the mailed questionnaire will be followed by a phone call, in an attempt to answer any questions you might have. This was found to be helpful by some of the respondents during previous rounds.

To speed up the process, these questionnaires will be sent by courier and it would be appreciated if you would also return them (collect) via courier.

Thank you for your continued cooperation

T.Dececchi

Task Description

You are being asked to evaluate a model for selecting which of a set of systems development approaches would be most suitable for developing a computer-based support system for a decision maker in a given situation. The development approaches are generic in the sense that they are an attempt to represent the majority of different approaches for supplying computer-based decision support in a few general ways.

The model used in the first round described situations in terms of three factors. Based on first round responses a fourth factor was added to the model for the second round. No further factors were added for the third round. The factors are:
(1) User Participation in the Decision Making Process
(2) Problem Space Complexity
(3) Resource Availability for the Development of Systems
(4) Organizational Context

Each of the factors is described in terms of a set of attributes. Based on your responses the following changes have been made for the third round:

(1) Organizational Culture has been dropped from the Organizational Context Factor.

The model assumes that situations can be adequately defined in terms of different combinations of these attributes. The resulting set of unique situations can then be associated with different systems development approaches. In the simplest case the model will match a situation with the most appropriate approach for developing a system. In a more sophisticated implementation the model would also be capable of backtracking, (suggesting which attributes have values indicating that a chosen approach might be less suitable).

Attached Documentation

The first part of the supporting documentation consists of (1) a description of the different generalized approaches to supplying support to the decision makers (2) a list of the four factors and their underlying attributes (3) the questionnaire itself.

The second part consists of three appendices. Appendix I contains summarized responses to the second round of the study, with which you may want to compare your opinions. Appendix II contains a description of the attributes. Appendix III is a bibliography.

If you have any questions please contact myself or Dr. Archer.

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Definitions of the Generalized Approaches to Supporting Decision Makers

Note that an approach is defined as consisting of both the final product (system) as well as the manner in which development took place.

Null Approach (NA)

No computer support.

System Development Life Cycle Approach (SDLC)

An information system that provides users with information, but little aid in analysis. It is developed using a systems life cycle approach, with analysis, design and implementation phases and with user participation in the process. The system focus is on collecting, organizing, storing and retrieving information. May have query facilities to allow for ad hoc requests or provision of new reports based on existing data.

Prototyping Approach (PA)

An information system that provides the users with information, but little aid in analysis. It differs from the SDLC in that it is developed in a recursive fashion, where the system is continuously growing and developing from an initially simple start utilizing continuous feedback from the users. It performs the same functions as the SDLC type system.

Decision Maker Centered Approach (DMCA)

A system which is designed to provide user support in all phases of the decision making process, providing the user with access to information, analysis tools and reporting facilities. It is developed with the end user in an evolutionary, participative fashion.

Decision Making System Approach (DMSA)

A decision making system which will produce a suggested decision for a decision ratifier. It will be developed with an expert, not the end user, in a participative evolutionary fashion.

List of Proposed Factors and Attributes

ATTRIBUTE	VALUES
USER PARTICIPATION FACTOR	High, Indeterminate, Low.
(1) Decision Maker or Ratifier	Decision Maker, Decision Ratifier.
(2) Degree of User Participation	Solicited-High Participation, Solicited-Low Participation, Unsolicited-High Participation, Unsolicited-Low Participation.
(3) Degree of User Discretion	Discretionary, Forced Use.
(4) User Decision Making Style	Autocratic, Consultative, Group.
(5)*Importance of Problem to D/M	Important, Unimportant
PROBLEM SPACE COMPLEXITY FACTOR	Complex, Moderate, Simple.
(1) Problem Uniqueness	Non-recurrent, Repetitive.
(2) Problem Set Definition	Multiple Problem Sets, Single Problem Set.
(3) Data Resource Specification	Simple Data Resources, Complex Data Resources.
(4) Range of Problems	Wide Range of Problems, Narrow Range of Problems.
(5) Interdependence of Decisions	Pooled, Sequential, Reciprocal.
(6) Problem Structure	Unstructured, Semi-Structured, Structured.
RESOURCE AVAILABILITY FACTOR	Null, Simple, No Constraints, DMSA
(1) Availability of Human Expertise	Available, Unavailable.
(2)*Developer Problem Space Knowledge	Experienced/Knowledgeable, Inexperienced
(3)*User Task Comprehension	Experienced/Knowledgeable, Inexperienced
(4) Availability of Technology	Available, Unavailable.
(5) Availability of Time To Develop Specific Systems	No Time Constraints, Time Constraints.
(6) Availability of Personnel To Develop Specific Systems	Development Staff Available, Low Staff Availability.
ORGANIZATIONAL CONTEXT FACTOR	Supportive, Non supportive
(1)*Organizational History	Previously Successful, Unsucessful
(2)*Organizational Resistance to Change	High, Low
(3)*Official Endorsement	Strongly Supported, Little Support
(4)*Organizational Environment	Stable, Unstable
(5)*Organizational Culture	Leading Edge, Conservative
(6) Organizational Decision Making Style	Socio-Political,Programmed Bureaucratic

Note: * Indicates a new or modified factor or attribute from the previous model.

VALIDATION OF THE MODEL STRUCTURE

In this section you are asked to rate each factor and each attribute. The scale is a five point Likert-like scale for rating the importance of each construct. The scale ratings range from unnecessary through indeterminate (neither clearly necessary nor clearly unnecessary) to very necessary. Please mark an X on each scale to indicate your opinion on the question: Is this attribute needed to determine the type of approach to be used in providing computer-based support for a decision maker in a particular situation?

The factors and their attributes are described in more detail in the appendices.

Factor I: USER PARTICIPATION IN THE DECISION MAKING PROCESS

Is it unnecessary/necessary to understand the level of a given user's participation in the decision making process in order to develop a computer-based support system for that decision maker?

¦__________¦__________¦__________¦__________¦
unnecessary indeterminate necessary

(1) Is it unnecessary/necessary to understand whether the user fills the role of decision maker, or that of decision ratifier, in deciding which approach to use for developing a computer-based support system for that user?

(For the purpose of this study a decision maker is defined as one who uses the system as an aid in making decisions, and a decision ratifier as one who accepts or rejects computer generated decisions.)

¦__________¦__________¦__________¦__________¦
unnecessary indeterminate necessary

(2) Is it unnecessary/necessary to understand the extent to which users need to participate in the development of a computer-based system for supporting their decision making activities, in order to determine the best approach to use in developing that system?

¦__________¦__________¦__________¦__________¦
unnecessary indeterminate necessary

(3) Is it unnecessary/necessary to know the degree of discretion that the end user will have with regard to using a computer-based support system, in order to select the most appropriate approach for developing that system?

¦__________¦__________¦__________¦__________¦
unnecessary indeterminate necessary

(4) Is it unnecessary/necessary to know what the end user's individual decision making style is, in order to select the most appropriate approach for developing a computer-based support system for that decision maker?

¦____________¦____________¦____________¦____________¦
unnecessary   indeterminate   necessary

(5) Is it unnecessary/necessary to know how important the problems in the problem space are to the decision maker, in order to select the most appropriate approach for developing a computer-based support system? **New Attribute**

¦____________¦____________¦____________¦____________¦
unnecessary   indeterminate   necessary

Please list and/or describe any additional attributes that you feel would help to describe factor. Any additional comments about this factor or its attributes should be included as well.

FACTOR II: PROBLEM SPACE COMPLEXITY

For this factor, complexity is from the perspective of developing a system to support a decision maker working in that problem space.

Is it unnecessary/necessary to know how complex the problem space facing the decision maker is, in order to select the most appropriate approach for developing that system?

|__________|__________|__________|__________|
unnecessary indeterminate necessary

(1) Is it unnecessary/necessary to know if the problem space is composed of (a) unique or non-recurrent problems, or (b) repetitive problems, in selecting the most appropriate approach for developing a computer-based support system for a decision maker?

(Repetitive problems are defined as problems which are themselves recurrent, or which belong to a set of closely related problems, and problems from that set will continue to confront the decision maker.)

|__________|__________|__________|__________|
unnecessary indeterminate necessary

(2) Is it unnecessary/necessary to know whether the problem space will consist of (a) a single problem domain, or (b) a set of distinct and different problem domains, in order to determine the appropriate approach for developing computer-based support for a decision maker?

|__________|__________|__________|__________|
unnecessary indeterminate necessary

(3) Is it unnecessary/necessary to know the level of complexity of the data resources required by problems in a given problem space, in order to determine the appropriate approach for supplying a decision maker with computer-based support?

(Simple data resources are defined as those that can be incorporated into a single data base, more complex data resources would be found in several different sources and could not be incorporated into a single source.)

|__________|__________|__________|__________|
unnecessary indeterminate necessary

(4) Is it unnecessary/necessary to know the range of problems within a single problem domain that a user may face in order to select the most appropriate approach to supplying computer-based support for a decision maker?

|____________|____________|____________|____________|

unnecessary indeterminate necessary

(5) Is it unnecessary/necessary to know the extent of interdependence between decisions (which this system will be designed to support), and decisions made by other decision makers, in order to select the most appropriate approach for supplying computer-based support?

|____________|____________|____________|____________|

unnecessary indeterminate necessary

(6) Is it unnecessary/necessary to know whether the problems in the appropriate problem space are well-structured or not, in order to select the most appropriate approach for supplying a computer-based support system for the decision maker?

(By well-structured it can be taken that the problems themselves can be described as structured, not that the decision maker in the process of solving these problems will impose a structure on them.)

|____________|____________|____________|____________|

unnecessary indeterminate necessary

Please list and/or describe any additional attributes that you feel would help to describe this factor. Any additional comments about this factor or its attributes should also be included.

FACTOR III: RESOURCE AVAILABILITY FOR SPECIFIC SYSTEMS DEVELOPMENT

Is it unnecessary/necessary to know the overall level of resources available to the systems development staff for the development of a particular computer-based support system, in order to select the most appropriate development approach?

|____________|____________|____________|____________|
unnecessary indeterminate necessary

(1) Is it unnecessary/necessary to know whether or not the human decision making expertise necessary to function effectively in a given problem space will continue to be available, in order to select which approach to supplying computer-based support would be most appropriate?

(It is assumed that in order to develop any type of system the domain specific expertise must at some point, be available.)

|____________|____________|____________|____________|
unnecessary indeterminate necessary

(2) Is it unnecessary/necessary to know the level of understanding the systems developer has of the problem space where the system will be implemented, in order to select the most appropriate approach for developing a computer-based support system?

(This understanding could have been obtained by previous work with systems for similar problem domains.)
New Attribute

|____________|____________|____________|____________|
unnecessary indeterminate necessary

(3) Is it unnecessary/necessary to know the level of comprehension the user has concerning the task of developing a support system for this problem space, in order to select the most appropriate approach for developing a computer based support system?

(This understanding could have been obtained from participation in previous systems development efforts.)
New Attribute

|____________|____________|____________|____________|
unnecessary indeterminate necessary

(4) Is it unnecessary/necessary to know the level of available technology, in order to determine the appropriate approach for developing a computer-based support system for a decision maker?

unnecessary		indeterminate	necessary

(5) Is it unnecessary/necessary to know the amount of time available to develop a specific system in order to select the most appropriate approach for developing that system?

unnecessary		indeterminate	necessary

(6) Is it unnecessary/necessary to know the availability of systems personnel, for the development of a specific system, in order to determine the most appropriate approach for developing a computer-based support system for a decision maker?

(The personnel may include contract staff or outside consultants.)

unnecessary		indeterminate	necessary

Please list and/or describe any additional attributes that you feel would help to describe this factor. If you have any additional comments about this factor or its attributes please include these as well.

Factor IV: Organizational Context Factor (New)

Note that all attributes in this factor are new, with the exception of attribute (6) which was transferred from the User Involvement factor in the initial model. In the questions in this factor, Organizational will refer to the end users organization, or organizational subunit, as opposed to the developer's organization (if different from the end user) or organizational subunit.

Is it unnecessary/necessary to understand something of the Organizational Context in which a particular system is to be implemented, in order to select the most appropriate approach for developing a computer-based support system for a decision maker?

¦____________¦____________¦____________¦____________¦
unnecessary indeterminate necessary

(1) Is it unnecessary/necessary to know whether or not previous systems development projects in the organization have been successful or not, in order to select the most appropriate approach for developing a computer-based support system?

¦____________¦____________¦____________¦____________¦
unnecessary indeterminate necessary

(2) Is it unnecessary/necessary to know the level of organizational resistance to change, in order to select the most appropriate approach for developing a computer-based support system for a decision maker?

¦____________¦____________¦____________¦____________¦
unnecessary indeterminate necessary

(3) Is it unnecessary/necessary to know the level of official endorsement or top management support for a particular system, in order to select the most appropriate approach for developing a computer-based support system for a decision maker?

¦____________¦____________¦____________¦____________¦
unnecessary indeterminate necessary

(4) Is it unnecessary/necessary to know the level of stability of the organizational environment in order to determine the most appropriate approach for developing a computer-based support system for a decision maker?

(This would involve some overall assessment of stability including factors relating to the external environment, and internal political stability.)

¦__________¦__________¦__________¦__________¦

unnecessary   indeterminate   necessary

(5) Is it unnecessary/necessary to know whether or not an organization has a given perception of its position with respect to the implementation of new technology, in order to select the most appropriate approach for developing a computer-based support system for a decision maker?

(Some possible perceptions could be "always on the leading edge of technological innovation" or "conservative, let the others work out the bugs first".)

¦__________¦__________¦__________¦__________¦

unnecessary   indeterminate   necessary

(6) Is it unnecessary/necessary to understand the organizational decision making style, in order to select the most appropriate approach for developing a computer-based support system for a decision maker?

¦__________¦__________¦__________¦__________¦

unnecessary   indeterminate   necessary

Please list and/or describe any additional attributes that you feel would help to describe this factor. If you have any additional comments about this factor or its attributes please include these as well.

SUPPORTING DOCUMENTATION

FACTOR I... USER PARTICIPATION IN THE DECISION MAKING PROCESS

The User Participation factor is operationalized as having three levels: low, indeterminate and high. This factor is characterized as user participation in the decision making process as opposed to user involvement. Here user involvement is taken in the following context: "individuals are said to be involved with an issue when it has intrinsic importance...or personal or psychological significance for the individual" [Barki and Hartwick 1987]. User participation is taken as a set of behaviors or activities performed by the users.

The users overall participation in the decision making process, that is the role he chooses to play, or is forced to play is one of the determining factors in selecting the type of support system necessary. User involvement, which has to do with the importance of the decision making process to decision makers is related to this in two ways. (1) It may affect how the user will structure the decision making environment (thus influencing the type of support system the user will want or accept). (2) It may influence the type of support system they would accept directly. Depending upon the importance of the problem to decision maker the decision maker may take a more or less active role in the decision making process. The contention behind this factor is that a user who exhibits a high level of participation in the decision making process will require a different type of support system, all other things being equal than one who exhibits a lower level.

It is postulated that the following attributes help to define the level of user participation in the decision making process:

(1) whether they see their role as a decision maker or a decision ratifier
(2) the importance of the decision to the decision maker
(3) the degree of discretion that they possess with regards to the selection and use of decision making tools
(4) their decision making style (5) the level of participation in the development of support systems that they need or are willing to accept.

Some of the organizational context factors would also appear to influence the level of user participation in the decision making process.

Other attributes which may be related have been separated out into an organizational context factor, which is discussed in a later section.

(1) Need for a Decision Maker or Decision Ratifier

Early definitions of DSS stressed their role in supporting rather than replacing decision makers [Alter 1980], [Keen and Scott Morton 1978], [Ginzberg and Stohr 1982]. Lee [1983] differentiated between expert systems which seek to replace the decision maker with a decision ratifier and DSS which support the decision maker. Others, however describe how DSS and ES can be merged in Expert Support Systems [Turban and Watkins 1986], [King 1986],[Fordyce 1986].

We must be careful to differentiate between those approaches which make use of AI technology to support (as advisors) and those which attempt to use it to replace (or substitute for) the decision maker [Adler 1984]. In doing this we have defined an approach (DMSA) which produces a system which replaces the human decision maker with a decision ratifier whose function is to accept or reject the computer generated solution (as did Lee [1983]). This is similar to the Ginzberg and Stohr [1982] definition of top managers as decision ratifiers who accept or reject the decisions of their subordinates without becoming involved in the decision making process. We have also defined three other approaches (SDLC, PA, DMCA) which produce systems for which the user must fill the role of decision maker with more or less support from the computer.

If the model suggests that a Decision Making Systems Approach is appropriate it is suggesting that the proper role for the user is that of a decision ratifier. In all other situations the user must remain a decision maker.

The attribute described here defines whether or not thepend user chooses or accepts the role of decision ratifier as opposed to decision maker. Adler [1984] suggests that one of the major problems with commercializing medical diagnostic expert systems is that doctors (like most other professionals) will accept computer based advisors, but not substitutes. They will continue to insist on remaining part of the decision making process, although they are willing to accept computer based support. If the user has enough discretion to accept or reject redefinition of his role, then he must accept this redefinition to decision ratifier if a DMS is to be successfully implemented.

Whether or not the user has this discretion, if their role is defined as one of decision ratifier then by definition they will have little or no participation in the decision making process.

(2) User Participation in Systems Development

There are two dimensions of this attribute, whether or not the user has solicited the system, and whether or not the user has a high need to participate in the development process.

Sprague and Carlsen [1982] suggest that a user who has solicited or initiated the systems development effort has more of a stake in the success of the system. Similarly Mahmood et al [1983] quote from Alter [1980] to show that DSS are more likely to be successful if they are solicited by either the user or top level management and that successful implementation is easier if the user has solicited the system. Their line of reasoning appears to be that a user who solicits a system will have enough of an understanding of the problem space to have identified the need for a system.

We must look at participation itself to understand the level of user participation. Debrabander and Edstrom [1977] and Debrabander and Thiers [1984] suggest that the type of interactions between the user and the systems developers can be related to systems success. If the user is forced into sham participation then it may be worse than no participation at all, because such a user may use the system as little as possible once it has been developed. Debrabander and Edstrom also suggest that effective communication will be defined differently in different situations. Similarly Oppelland and Kolf [1980] have defined different levels of user participation as being appropriate in different situations.

In a paper comparing Institutional and Ad Hoc DSS Donovan and Madnick [1978] describe Institutional DSS as supporting a narrow range of users, and a narrow range of decisions. Systems of this type need to be supplied with data in advance and support few decision types and a large number of people. Turban and Watkins [1986] in comparing ES and DSS note that ES operate on a narrow problem range and solve repetitive problems. Our definition of DMS specifies that they need to be supplied with an initial database and suggests service to a great many users in similar situations. It would appear therefore that there are similarities between Institutional DSS (as defined by Donovan and Madnick) and ES (as defined by Turban and Watson) and our definition of DMS.

One key "physiological" similarity is that these types of systems have to some extent reduced the participation of their users in the decision making process. Institutional DSS do this by reducing the discretion of their users by selecting the methods and/or the tools for solving the problems as well as the data that will be used to solve the problems. ES (as defined by Turban and Watkins [1986]) could still allow the user some role in the decision making process but it would appear that much of the process has been automated. DMS carry this to the extreme by completely automating and controlling the Decision Making Process. This corresponds to the relationship between system type, user role and the need for user participation (and could explain the results of Mann and Watson [1984] who appear to be describing an Institutional DSS).

We will postulate that the need for the user to participate in the development of the system is related to their participation in the decision making process itself. This variable will then be operationalized as the following four values :

"Solicited" - High user need to participate in development
"Solicited" - Low user need to participate in development
"Unsolicited" - High user need to participate in development
"Unsolicited" - Low user need to participate in development

(3) User Discretion

This attribute is closely related to attribute (1). Whether or not a user will accept or reject a given role depends on the amount of discretion they have. However the amount of discretion that the user has may effect strategy selection beyond whether or not they will accept a role as a Decision Maker or a Decision Ratifier.

If we consider the situation where the user is left in the role of decision maker they may have considerable discretion over whether or not they will use the system in a given situation. Methlie [1983] states that many users of DSS have considerable discretion over how and when they will perform a specific task and a choice as to the tools that they will use. Young [1983] also states that the managerial user will retain control over the task and outcome and Lucas [1978] suggests that DSS users have more discretion than other system users.

We will operationalize this concept as a dichotomous variable with values "discretionary" and "forced use". A discretionary user would be able to choose not only the type of support system, but the method used to solve the problem, the data needed etc. A forced user of the system would be less involved in the decision making process to the extent that at least some parts of that process are beyond their control (i.e. whether or not to use computerized support).

(4) User Decision Making Style

The Vroom-Yetton [Vroom 1973] model divides five different decision making styles into three "classes". The first consists of AI or AII styles ("autocratic" decision making). The second consists of CI and CII styles (a "consultative" approach to decision making that still leaves one individual in charge). The last would be GII which represents true "group" decision making.

In situations which could be described as autocratic, where the decision making is done by a single individual it is possible that one could remove the user from the decision making process by making them a decision ratifier. This would allow the system to make the decisions, all other things being equal.

In situations where there is some need for group involvement in the form of consultation (usually because several types of expertise or sources of data are needed) the user would probably be more involved in the decision making process. This is because humans tend to be more flexible [Robey 1983] and better able to handle multiple inputs then computers are [Turban and Watkins 1986].

By definition situations which require GII decision making styles require some form of group consensus, meaning that those affected by the decision must participate in the decision making process.

(5) Importance of Problem to the Decision Maker

This is one of the factors suggested by the participants in the survey. Some of the comments included when asked for additional attributes were "Importance of the problem to the decision maker ", "Interest or willingness of the individuals", "Crises Occurring". These all seem to have a common element of addressing the user perception of the problem as being important in defining the user's participation in the decision making process.

This is operationalized as "important" and "unimportant".

FACTOR II... PROBLEM SPACE COMPLEXITY

This factor is operationalized in three levels, complex,moderate and simple. It is assumed that problems that can be defined as more complex will help define situations that are more amenable to systems that make more use of the human decision maker in their solution. The complexity refers to the task of developing support systems to function in the problem space.

(1) Problem Uniqueness

There are two considerations here. The first is whether the problems are unique or ad hoc, or whether they are recurring. The second is whether they are unique to one user or found organization wide. Many authors have stated that ES are only appropriate in situations where problems are recurrent [R.Davis 1983], [Turban and Watkins 1986] etc. This is similar to Institutional DSS [Donovan and Madnick 1977] as compared to Ad Hoc DSS. If the computer system must be designed to take over more of the Decision Making process, then it will be more complex, more expensive and there will be less of a payback in situations of limited use. In the extreme case it is difficult to see how one can justify using an expert to develop a system to mimic his or her judgment, then test the system with the expert on realistic test cases, if the problem itself is unique and will only need to be solved once. On the other hand there are many cases where DSS have been developed for a single application.

We will operationalize this variable in a dichotomous fashion. One value will be "non recurrent" and it will be taken to mean that the problem is either one of a kind or found sufficiently rarely in the organization as a whole so that it can be taken as unique. The other value, representing problems that occur more frequently, will be labeled "repetitive".

(2) Problem Set Definition

Turban and Watkins [1986] in comparing ES and DSS suggest that ES are more suitable for a narrow domain and DSS for a wider problem domain. ES performance in general "degrades rapidly" outside a narrow area of expertise [R.Davis 1984]. Donovan and Madnick [1977] in their comparison show Ad Hoc DSS more appropriate for situations where there is a wider problem domain then Institutional DSS. It appears that the more of the decision making process that is automated, the less flexible the system. From a systems development point of view, the need to handle more then one problem set would create a more complex problem space in that it would take a more sophisticated system to deal with this variety.

This variable is operationalized as either "Multiple Problem Sets" or a "Single Problem Set".

(3) Data Resource Specification

This attribute represents the complexity of data resources required by a particular problem, so it is an attribute in the problem space attributes factor rather than one in the resources factor. This attribute will be operationalized as either "simple data resources" or "complex data resources". A problem space requiring "simple data resources" is one where the data can be prespecified or at least access to the data can be prespecified in some sense. A problem space requiring "complex data resources" is one where the data required to solve the problem (and the source of that data) cannot be specified a priori. This is based on the Donovan and Madnick [1977] comparison of Institutional and Ad Hoc DSS and the problems other researchers have reported in connecting ES to multiple data sources. It would appear that the greater the number of sources the more complex the problem of designing a system to access these sources, especially if there is no certainty over which sources should be used.

(4) Range of Problems

Even if a problem space can be said to encompass only one type of problem (one problem set) one may still be able to define a range of problems within the problem set. This is especially true in the case where the system is expected to grow and develop with the user.

Unless the support system can be "fully developed" initially, to provide support for the entire range of problems within a problem set (which evolutionary proponents of DSS argue may neither be possible nor desirable) it must be able to grow with the user. R.Davis [1984] suggests that in the future expert systems may be able to learn, although none can today. However even if they do develop some improvement capabilities this will most likely be limited to improving probability estimates used in diagnostic systems or optimizing programme efficiency rather than expanding the range of problems that they can solve [Hayes-Roth 1983].

This variable will be operationalized as a dichotomous variable with values "narrow range of problems" and "wide range of problems". If there is a narrow range of possible problems in the problem space then one may be able to design a system to support a decision maker in the majority of probable situations. However if there is a wide range of problems in the problem space then it is more likely that the system will have to evolve over time to meet the users specific needs.

(5) Interdependence of Decisions

This attribute can be operationalized in terms of a three valued taxonomy [Thompson 1967]. "Pooled" refers to decisions which are basically independent. "Sequential" to systems in which decisions are made serially with each decision based on the previous one in a linear fashion. "Reciprocal" refers to decision making processes where decisions from one decision maker affect those made by another, and in turn those decisions may affect the decisions made by the first decision maker, in a type of feedback process.

Basic systems theory [Davis 1984] tells us that if we can break a system into a set of minimally interacting subsystems, the job of design and maintenance of that set of smaller systems will be simpler than the job of designing and maintaining a single larger system of comparable size. The more interaction between decision makers (human or automated). the less independent the decision making subsystems are and the more complicated the task of designing support for them.

(6) Problem Structure

This attribute will be operationalized using the Simon taxonomy of "structured" , "semi-structured" and "unstructured" problems. It is assumed that it may be possible to specify at the time of system development some idea of the degree of structure the problems will possess. This is not to say that the problems cannot be broken down into structured and less structured segments, but that this cannot be done a priori. The concept that it is a more difficult task to support users in a less structured problem space is rooted in much of the DSS literature [Scott Morton 1971], [Alter 1980].

FACTOR III...RESOURCE AVAILABILITY

The resource availability factor will be assigned four values representing points on a scale from no support possible ("null"), through restricted support possible ("simple"), to no restrictions on the support available ("no constraints"), to the need for computer controlled decision making ("DMSA").

Null-------------- Implies that it will not be possible to provide computerized support due to the lack of resources.
Simple System---- This means that the availability of resources will force the choice of more basic support systems. This will mean different things in conjunction with combinations of the other factors.
No Constraints--- This means that resources will not constrain the choice of strategy as suggested by the other factors.
DMSA------------- Implies that it will be necessary to supply a Decision Making System due to the lack of available, problem specific, human expertise.

(1) Availability of Human Expertise

This attribute is meant to represent whether or not a capable human decision maker exists in the situation. If not then it will be necessary to supply a computerized decision maker. One of the arguments behind research to develop expert systems has been the scarcity of human expertise in certain fields and therefore the need to "clone" this expertise [Whinston 1984]. It is operationalized as a dichotomous variable with values "available" and "unavailable".

(2) Developer Problem Space Knowledge and (3) User Task Comprehension

The higher the level of task comprehension by the user and the knowledge of the developer of the task of developing support systems for this particular problem space the greater the probability that the system can be prespecified [Davis 1982]. If the opposite is true than the system will most likely need to undergo some form of evolutionary development. These variables are both operationalized as having two values "experienced/knowledgeable" and "inexperienced"

For developer problem space knowledge:

Experienced/Knowledgeable-- The developer has a good understanding of the problem space the user is facing either by having developed similar systems or by having some knowledge of the user's task because of previous training.
Inexperienced--------------- The developer has little understanding of the problem space faced by the user.

For user task comprehension

Experienced/Knowledgeable--- The user has a good understanding of the use of support systems in this particular problem space either by having previously cooperated in a similar project or having had some formal training in the field.

Inexperienced -------------- The user has little understanding of how a computer based system might be useful, or of how it might be developed.

(4) Availability of Technology

Operationalized as either appropriate technology being "available" or "unavailable" at a cost beneficial price for a specific project. Note that although the appropriate software might exist it may be too expensive for use in a particular situation. For example a framework package may exist that is suited for one particular application but it would require the purchase of specific hardware so that the total cost would be prohibitive. Or there may not be appropriate commercial software available for a particular application so that the system would need to be developed from low level tools (Prolog, Lisp, a DBMS, a procedural language etc.) which would increase the cost and time required to develop the system.

(5) Availability of Time to Develop Specific Systems

This attribute represents whether or not the time to develop a system is a major constraint. It is operationalized as "no time constraints" and "time constraints". Donovan and Madnick [1977] suggest that Ad Hoc DSS (which leave more of the Problem Processing with the user) are more appropriate (or realizable) than Institutional DSS in situations where time is critical. Similarly unless there are existing ES available, it would appear [Hayes-Roth et al 1983], [R. Davis 1984] that it takes a considerable amount of time to develop a DMS. Also Mahmood et al [1983] suggest that if the time frame is short term normally some form of crash design be used. This would appear to suggest that if there are major time constraints then one would need to rely more on the user and less on the system, because a less complex system could be developed.

(6) Availability of Personnel To Develop Specific Systems

This attribute measures whether or not there are sufficient support staff to provide aid to develop individual systems. It will be operationalized as "Development Staff Available" and "Low Staff Availability".

FACTOR IV: ORGANIZATIONAL CONTEXT

Several of the respondents felt that it was necessary to take into account the organizational context in an explicit fashion. Examples of other models where this is done (Leavitt Diamond) were given and also individual attributes based on organizational context were suggested. Mason and Mitroff's [1973] seminal paper "A Program for Research on Management Information systems" can be taken as the beginning of the accepted tradition of contextual approaches for analyzing information systems issues. In this paper they proposed that the "organizational context" of an information system influenced its design and use. Ein-Dor and Segev [1978] suggested that the successful development of information systems depended in part on their organizational context, that is in certain organizations the probability of successfully developing information systems was increased. They empirically studied the effects of four of the organizational context variables that they had suggested. Olsen,[1978] and Olsen and Chervany [1980] studied the relationship between organizational characteristics and the structure of the information services function. In the late 1970's and early 1980's several other authors also studied the relationship between organizational variables and characteristics of IS.

If we return to the 1978 model of Ein-Dor and Segev, organizational context variables have been subdivided into three categories, uncontrollable, partially controllable and controllable (from the perspective of implementation of an MIS). The uncontrollable variables include organizational size, structure, organizational time frame and extra organizational situation. The partially controllable variables include organizational resources, organizational maturity and the psychological climate. The controllable variables include the rank of the responsible executive, the location of the responsible executive, and factors concerned with the steering committee.

In this section a reduced set of organizational context variables will be proposed, because it is believed that many organizational factors affect the availability of resources. The issue of availability of resources is addressed separately, so it is not necessary to address many of these underlying issues.

Based on the responses of the users these are the proposed organizational context attributes.

(1) Organizational History

This could best be described as the history of the organization with other computer based systems. It is postulated that if the organization has a bad history, then the individuals in the organization will have less of a predisposition to working with computer systems. This corresponds roughly with the Ein-Dor and Segev factor of Psychological Climate. It differs from the Resource Availability attribute of User Task Comprehension, because although the user may have worked with previous systems, and personally know what can be done with computers, and may actually feel that they are beneficial, he may be alone in his beliefs and not actively support the development of a system believing the risks if it fails are more significant than the rewards if it succeeds.

The converse could also be said to be true, in that if the organization has had a history of successful use of computer based support systems, then there is some organizational impetus that will "force" the user to make use of the available resources, even if they are unsuitable. In this context we could say that if the organizational history was "previously successful" then it will increase the probability that more sophisticated systems will be implemented over the case where the history was "unsuccessful".

(2) Organizational Resistance to Change

This factor has also been suggested by the delphi panel members. It can be interpreted in one of two ways. In fewer and fewer organizations there is a complete lack of experience with computer based systems. In these organizations the implementation of computer based systems would represent a major change. Since major changes may be stressful to the members of an organization, there would be a natural resistance to change in that organization. In other organizations, there can be a distinct traditional sense, even though they make use of technology, they are reluctant to do so. A value is placed on doing things the way they have been done and it is more difficult to justify changing the status quo.

This variable could be interpreted as having two states, "high" resistance to change, (meaning that it will be more difficult to implement more sophisticated technology) and "low" resistance.

(3) Official Endorsement

Many writers on organizational context suggest that an important factor affecting the success of implementation of an MIS is the official organizational support. This can take many forms: the organizational position of the MIS executive is sufficiently high in the organization, or the steering committee is placed high enough in the organization [Ein-Dor and Segev 1978] so that it can exert true pressure to have changes made and make available the necessary resources, or the executives themselves are supporting of the use of computer based support systems. Official endorsement then can have two effects, it can improve the organizational climate to make systems development more acceptable, or it can free up resources, to make it more possible. It could be operationalized as having two states "strongly supported" and "little support".

(4) Organizational Environment

Ein-Dor and Segév suggest that factors from both the organization's internal and external environment affect the implementation of IS in that organization. These factors could include the stability of the environment, the market share, the industrial markets in which the organization competes, the internal stability (stability of management, stability of process technology). Duncan in an early article on organizational environments says that both the internal and external environment must be considered.

The postulate here is that organizations that face more uncertain environments will have more complex decision making tasks than those who face more stable environments (similar to what Galbraith [1974] says), and in the more complex environments it will be more necessary to provide more sophisticated support systems because they will need not only better data, but better tools to manipulate and transform that data into information. It could be operationalized as having two states "stable" and "unstable".

(5) Organizational Culture

This attribute has also been suggested by the delphi panel. This attribute corresponds to Ein-Dor and Segev's propensity to pioneer. In some organizations there is a belief that one should be at the leading edge of technology. Sometimes this is driven by the external environment facing the organization, where the use of IS in that particular industry has become of strategic importance and to fall behind would be costly. At other times it may have to do with the perceptions of the individuals in the organization. They feel proud of the reputation that their organization has.

Other more conservative organizations may adopt different strategies with respect to the implementation of technology. They may have decided that they will not be left behind, but that it is either too risky to try and be the leader, or that it does not fit their image to attempt new and different approaches.

However the organization defines itself in relation to technology, the organizational culture can be important in how new systems technology is brought into the organization, and in how different approaches to supporting decision makers are selected. "Leading edge" and "conservative" companies may require different computer based support systems for their decision makers.

(6) Organizational Decision Making Style

This attribute can be operationalized in terms of four styles as described by Huber [1981] or five as described by Keen and Scott Morton [1978]. For our purposes we will define two dichotomous styles based on these definitions:

If the organization has chosen to combat environmental uncertainty [Galbraith 1974] by developing standard operating rules or procedures for decision making, or if the organization has a rational form of decision making with well defined and coordinated goals and objectives then the user will be less involved in the decision making process to some extent, all other things being equal. This is because the "rules" have already been made so in a sense there are no decisions to make, only policies to enforce. The decision maker serves more as a decision ratifier, intervening only in exceptional circumstances where the rules may not apply. (This would represent a "programmed bureaucratic" style).

If the organization has chosen to combat the environmental uncertainty by developing expertise among its human decision makers or if it presents an environment where decisions are made on social or political considerations ("Socio-political") the decision maker will be highly involved in the decision making process, all other things being equal. There are two possible reasons for this.

(1) These situations are difficult to structure a priori, lessening the use of the computer as a decision making tool (according to most writers of DSS who have made use of the Gorry and Scott Morton framework).

(2) There exists a need for local expertise, that is the special situation dependent knowledge that only someone in the organization can possess.

APPENDIX III

COMMENTS FROM RESPONDENTS TO THE DELPHI STUDY

Part One

-The model should resemble the Leavitt diamond.
-The need for a decision maker or decision ratifier depends on system type.
- Data Resource Specification should be moved to the Resource Availability Factor
-That analytics will be more involved in the DM process is not well supported
-Problem Space attribute problem type is not well supported by arguments
-Argument about being able to build more complexity into system if uncertainty is low is not straight forward
-Participation vs. involvement
-The assumption of analytic more involved is questionable
-Do you differentiate between IS developers "expertise" in developing such systems and expertise with the task to be supported.

-Additional attributes for factor one could include
- -user/organizational resistance to change
- -top management endorsement of task
- -importance of problem to decision maker
- -past history or experience of individuals (or organization) with related situations (task or experience) as an additional attribute for first factor
- -interest or willingness of individuals

-Additional attributes for factor two could include
- -model specification
- -problem consensus among dms (objectives, definition)

-Additional attributes for factor three could include
- -availability of consultants (outside experts)
- -availability of funds
- -additional attributes for resources could include user or organizational experience or history. If you have a successful batting average with highly complex systems you are more apt to undertake new complex systems (all other things being equal)

-Additional factors could include
- -Organizational Context
  - -Crises occurring
  - -Political Stability
  - -Managerial Team Stability
  - -Market Stability
  - -Competitive Pressures a system may be necessary to catch up or keep alive
  - -experience with technology, not just the availability of technology
- -Additional Factors could be Organizational Culture to the extent that it doesn't come through in the user involvement factor i.e. the idea of being a leading edge company, or one that may not be first, but will not be far behind.

Note : Because of the changes to the model the second part of the questionnaire dealing with the operationalization of the model in a decision tree will not be included in the second round. This was part two of the original questionnaire.

Comments from Round 2-
(1) referring to User participation in the Decision Making Process

- this can be users' perceived need to participate (in the development of a system) (which implies want) or it could be the system developer's opinion as to how much users need to participate in the development of a system

RESPONSE : It is intended to be taken as the users subjective need to participate in the development of the system as opposed to the system developer's view of the need. It is postulated that how the user views his tools (and the support system is a tool) is related to how actively he participates in the decision making process.

-The term user participation invokes thoughts of "user participation in systems development" Ditto for involvement. However I believe you are using these terms in the context of "decision making" in one's job. My answers are based on this assumption.

RESPONSE: That is the correct assumption

- suggested new attribute
  -nature/existence of rewards for participation

(2) referring to Problem Space Complexity Factor

- There is an interesting issue which this questionnaire stirs. Should systems be designed for knowledge workers at a particular point in time? That is should emphasis be placed on defining requirements for a particular dept. or individual for a given organizational context for a particular period of a firms history. This is in contrast to designing normative data base for an organization throughout its life cycle. One could refer to it as the DMSA approach vs. the Integrated Database Approach.

NO RESPONSE

- The items in this category have a lot of overlap. I.E. is it possible for a "well structured" problem (item #6) to have a "non recurring" nature (item #1) and a "complex" data resource(item #3)?

RESPONSE: These attributes are not meant to be mutually independent. There are combinations of these attributes that are not realistic.

- suggested new attributes
  - level of managerial activity
  - level of uncertainty

(3) Comments on Organizational Context Factor

- I am not sure about the new factor. I don't see how it relates? I assigned my value based on my own experience of relative importance of problems
-suggested new attribute
  - existing organizational practice

APPENDIX IV

SAMPLE INSTRUMENTS FROM THE SECOND PHASE OF THE VALIDATION PROCESS

Questionnaire

This study is part of a research programme whose goal is to develop a model to aid in the selection of an appropriate approach for supplying computer based support systems for decision makers. In the initial phase of this research a model detailing a list of factors (and their defining attributes) which influence the selection of systems was developed and validated. In this phase of the research programme we are attempting to ascertain how these various attributes interact.

For the purpose of selecting the appropriate approach for developing support systems situations can be described in terms of the various factors and their underlying attributes. We are attempting to associate various factor values with the different combinations of attribute levels in different situations. Future research will try to associate different combinations of factor values with different approaches for developing support systems.

The four factors identified in the first phase of the research were:

(1) User Participation in the Decision Making Process

(2) Problem Space Complexity

(3) Resource Availability

(4) Organizational Context

For each factor you will be given a definition of that factor and definitions of each of the attributes which define that factor. You will then be asked to answer a series of questions associating sets of the attribute levels with factor values.

To aid you in this task you will be asked to place a card with the various attribute levels on a "factor value thermometer". This thermometer has a scale ranging from "0" to "100" with verbal cues associated with the ranges of factor values arranged along this scale. You will be asked to place each card at the appropriate point on the scale.

For example if you feel that the situation defined by the first set of attributes makes it highly preferable or very desirable for a high level of Factor I then you would place the HIGH LEVEL card at or near the "100" level.

If you feel that the situation defined by the first set of cards makes it undesirable for a low level of Factor I you would place the LOW LEVEL card at or near the "0" level.

If you felt that the situation as defined by the first set of attributes wouldn't necessarily make it either undesirable or desirable for an intermediate level of Factor I you would place the INTERMEDIATE LEVEL card somewhere near the middle of the scale.

Factor 1: User Participation in the Decision Making Process

The purpose of the model is to select the most appropriate method of supplying computer based support to decision makers. One factor that will affect which approach to take in developing a support system for a particular user is the level of participation of the user in making the decisions. For this study USER PARTICIPATION is defined as the set of behaviors or activities performed by the users. This differs from USER INVOLVEMENT which is the psychological state of the user and represents the importance and personal relevance of the issue. User participation in the decision making process has been assigned three values:

Low---------------- Low level of participation in the decision making process by the actual decision maker.

Intermediate-------- Intermediate level of participation in the decision making process by the actual decision maker.

High--------------- High level of participation in the decision making process by the actual decision maker.

There are four attributes used to define this factor :

(1) User Role in the Decision Making Process
(2) User Participation in the Development of the Information System
(3) Level of User Discretion in Use of the Information System
(4) Importance of Problem to the Decision Maker

Attribute Definitions

(1)Role in the Decision making process (Values: Decision Maker,Decision Ratifier)

This attribute defines whether or not the end user would choose or accept the role of decision ratifier as opposed to that of decision maker.

A decision ratifier either accepts or rejects proposed solutions.

A decision maker takes part in the decision making process itself . A decision maker would insist on controlling some or all of the different phases of that process. These could include selection of the data resources or the problem solving strategies, development of criteria, development of alternatives, selection of proposed solution from the alternatives etc.

(2) User Participation in the Information Systems Development Process (Values: Solicited-High,Solicited-Low, Unsolicited-High,Unsolicited-Low)

There are two dimensions of this attribute: whether or not the user has solicited the information system, and whether or not the user has a high need to participate in the development process itself.

There has been some research which suggests that a user who has solicited or initiated a request for computer based support will have more at stake in making sure that the system is a "success".

Similarly if a user has solicited the system then the user will be exhibiting some control over the choice of tools, data sources etc. used in the decision making process. Therefore a user who solicits a system shows more participation in the decision making process than a user who doesn't, all other things being equal.

If a user has a high need to participate in the development of a support system it indicates that the user has a need to control these aspects of the decision making process.

These two attributes are not viewed as operating independently, but rather in concert, combining into a single four level attribute. The levels are:

(1) Solicited-High User Need To Participate in Information Systems Development (Solicited-High)
(2) Solicited-Low User Need To Participate in Information Systems Development (Solicited-Low)
(3) Unsolicited-High User Need To Participate in Information Systems Development (Unsolicited-High)
(4) Unsolicited-Low User Need to Participate in Information Systems Development (Unsolicited-Low)

(3) Level of User Discretion (Values:Discretionary,Forced Use)

This attribute is closely related to the attribute which specifies the role the decision maker is willing to accept. Whether or not a user will accept or reject a given role has to do with the amount of discretion that the user has. However given that the user has chosen to remain a decision maker the user may still choose whether or not to use this support system or any other approach to decision making.

A discretionary user is one who can choose the tools he/she will use in the decision making process (and specifically who can choose whether or not to make use of a given support system.)

A forced user will in general not have the choice of tools to use in the decision making process (and specifically will be expected to make use of the support system that is supplied).

(4) Importance of the Problem to the Decision Maker (Values:Important,Unimportant)

It is assumed that if the particular type of problems that the support system is designed to help solve are of importance to the decision maker they will be more inclined to participate in the decision making process.

Conversely if the particular problems that the support system is designed to help solve are not of importance to the decision maker, they will be less inclined to participate in the decision making process itself.

Case #1

You are an engineer who has just been promoted to project manager for a large engineering design firm. Similar to many other engineers recently promoted to management you feel that the most important aspect of your job is to ensure that the technical quality of the deliverables is as high as possible. You consider that keeping the projects on time and under budget to be of very limited importance to everyone except the "bean counters". You have spent your entire career as a design engineer and you still see yourself as primarily an engineer, in fact as the chief engineer on the project. You believe that if design improvements can be made, then they should be, and if it means going over budget, or being late, so be it.

Although you work with your staff, you feel that a "Hands-Off" decision making style similar to that attributed to President Ronald Reagan, would not be responsible. You feel that as a decision maker you must do more than accept or reject the decisions that your subordinates have made. If you are going to be responsible for a decision, you want to know the background behind it, where the data came from and what the alternatives were. In other words you have a need to "work through the numbers", yourself.

Since you are responsible for seeing that the projects are on time and under budget, one of your tasks is to notify different departmental managers (whose employees actually do the project work) if they are significantly behind schedule or over budget on the sub-project that they are responsible for, and to try and get them back on schedule. You have recently been supplied with a new computer-based project management support system. You didn't ask for it, and you had little or nothing to do with its development. To the extent that you "use" it ~~because~~ you do so because you are forced to.

This new system that just appeared can provide you with many types of different reports. At its most basic level it produces a list of all sub-projects, including the manager responsible for each sub-project and whether or not it is behind schedule or over budget. At a more advanced level the system can be used to determine the effect on the projected project completion date of various sub-projects falling behind schedule by differing amounts. It can also perform sophisticated analysis of variances of new forecasts from previous forecast values of time to completion and budget for various sub-projects.

A HIGH level of user involvement in the project management aspect of your job might be to use the analysis capabilities of the system to prepare a list of sub-projects that are in significant trouble, and then to use the system to determine the effects on the overall project, and how to get the project back on track (or at worst to minimize damage).

A LOW level of user involvement in the project management would be to simply send copies of the original list to all departmental managers with a note asking them to take appropriate action.

(1) In this situation how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(2) If you have been told that your continued employment depends on the project being on time and under budget how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(3) If you had the discretion to choose whether or not to use any project management tool, (i.e. Pert, CPM, or any computer system incorporating these as well as this system) how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(4) If you have the discretion to choose which tools to use, including whether or not to use this system, and your continued employment is dependent on the project being on time and under budget how desirable or preferable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

Let's now consider changing the original situation a little. You would describe your responsibilities or role in the same way, but now consider that you are convinced that computers are the way of the future. Because of this you are the one who requested computer based support systems for all aspects of your job, including the scheduling and budgeting aspects. As a matter of principle you feel that by the late 1980's any technically advanced company should have automated its information systems. Because you attach little importance to this particular system you have no need to participate in the development of this system and in fact you have not participated in its development.

(5) In this situation how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(6) If you have been told that your continued employment depends on the project being on time and under budget how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(7) If you had the discretion to choose whether or not to use any project management tool, (i.e. Pert, CPM, or any computer system incorporating these as well as this system) how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(8) If you have the discretion to choose which tools to use, including whether or not to use this system, and your continued employment is dependent on the project being on time and under budget how desirable or preferable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

Let us change the original situation again. Like the other two situations, you are an engineer and you view your role in a similar perspective. This time you nave not requested any computer support, but upon hearing that they were developing a system, you asked to help develop the system. You feel that if you are going to end up getting one anyway, you want to have some say in what you are getting. Your attitude may be based upon a perceived matter of principle, or it may be an expression of your distrust of the systems people.

(9) In this situation how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(10) If you have been told that your continued employment depends on the project being on time and under budget how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(11) If you had the discretion to choose whether or not to use any project management tool, (i.e. Pert, CPM, or any computer system incorporating these as well as this system) how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(12) If you have the discretion to choose which tools to use, including whether or not to use this system, and your continued employment is dependent on the project being on time and under budget how desirable or preferable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

Let us change the situation again. Like the other three situations you are an engineer and you view your role in a similar perspective. This time you consider that computers are the way of the future and you have requested computer based support systems for all aspects of your job including the scheduling and budgeting aspects. Furthermore you have asked to help develop the system, because you feel that if you are going to get a system you want to make sure that you have some say in what you are getting. You do not find the task of project management important, but you feel that in the late 1980's all information systems should be computer based in any technologically sophisticated organization.

(13) In this situation how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(14) If you have been told that your continued employment depends on the project being on time and under budget how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(15) If you had the discretion to choose whether or not to use any project management tool, (i.e. Pert, CPM, or any computer system incorporating these as well as this system) how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(16) If you have the discretion to choose which tools to use, including whether or not to use this system, and your continued employment is dependent on the project being on time and under budget how desirable or preferable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

For the remaining questions consider that you have just returned from a week long management skills course. Having been convinced of its value you have adopted a decision ratifying style. Although you will still retain the responsibility for making the decisions, for all intents and purposes these decisions will now be made by your staff. You will call staff meetings to listen to your staff members present their work, and at the end of each members presentation , you will either accept or reject their recommendations.

In the next four situations you have neither requested the system, nor had worked on the development of the system, similar to the original situation.

(17) In this situation how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(18) If you have been told that your continued employment depends on the project being on time and under budget how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(19) If you had the discretion to choose whether or not to use any project management tool, (i.e. Pert, CPM, or any computer system incorporating these as well as this system) how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(20) If you have the discretion to choose which tools to use, including whether or not to use this system, and your continued employment is dependent on the project being on time and under budget how desirable or preferable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

Let's now consider changing the. You would describe your responsibilities or role in the same way, but now consider that you are convinced that computers are the way of the future. Because of this you are the one who requested computer based support systems for all aspects of your job, including the scheduling and budgeting aspects. As a matter of principle you feel that by the late 1980's any technically advanced company should have automated its information systems. Because you attach little importance to this particular system you have no need to pa$icipate in the development of this system and in fact you have not participated in its development.

(21) In this situation how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(22) If you have been told that your continued employment depends on the project being on time and under budget how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(23) If you had the discretion to choose whether or not to use any project management tool, (i.e. Pert, CPM, or any computer system incorporating these as well as this system) how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(24) If you have the discretion to choose which tools to use, including whether or not to use this system, and your continued employment is dependent on the project being on time and under budget how desirable or preferable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

Let us change the original situation again. Like the other two situations, you are an engineer and you view your role in a similar perspective. This time you nave not requested any computer support, but upon hearing that they were developing a system, you asked to help develop the system. You feel that if you are going to end up getting one anyway, you want to have some say in what you are getting. Your attitude may be based upon a perceived matter of principle, or it may be an expression of your distrust of the systems people.

(25) In this situation how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(26) If you have been told that your continued employment depends on the project being on time and under budget how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(27) If you had the discretion to choose whether or not to use any project management tool, (i.e. Pert, CPM, or any computer system incorporating these as well as this system) how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(28) If you have the discretion to choose which tools to use, including whether or not to use this system, and your continued employment is dependent on the project being on time and under budget how desirable or preferable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

Let us change the situation again. Like the other three situations you are an engineer and you view your role in a similar perspective. This time you consider that computers are the way of the future and you have requested computer based support systems for all aspects of your job including the scheduling and budgeting aspects. Furthermore you have asked to help develop the system, because you feel that if you are going to get a system you want to make sure that you have some say in what you are getting. You do not find the task of project management important, but you feel that in the late 1980's all information systems should be computer based in any technologically sophisticated organization.

(29) In this situation how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(30) If you have been told that your continued employment depends on the project being on time and under budget how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(31) If you had the discretion to choose whether or not to use any project management tool, (i.e. Pert, CPM, or any computer system incorporating these as well as this system) how preferable or desirable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

(32) If you have the discretion to choose which tools to use, including whether or not to use this system, and your continued employment is dependent on the project being on time and under budget how desirable or preferable do you feel it would be to have a HIGH level of participation in the decision making process? A LOW level? An INTERMEDIATE level?

FACTOR IV: ORGANIZATIONAL CONTEXT

The purpose of this model is to select the most appropriate method of supplying computer based support to decision makers. One factor that will affect which approach to take in developing a support system for a particular user is the Organizational Context. In this section a reduced set of organizational context variables will be proposed, because it is believed that many organizational factors affect the availability of resources. The issue of availability of resources is addressed separately, so it is not necessary to address many of these underlying issues. The Organizational Context factor has been assigned two values:

Supportive ----------- The organizational context is conducive to the development of computer based systems.

Non-supportive-------- Factors in the organizational context will hinder the development of computer based support systems for decision makers.

There are 4 attributes that help to define this factor:

(1) Organizational History
(2) Organizational Resistance to Change
(3) Official Organizational Endorsement
(4) Organizational Environment

Attribute Definitions

(1) Organizational History (Values: Successful, Unsuccessful)

This can be described as the history of the organization with other computer based systems. If the organization has a bad history, then the individuals in the organization will have less of a predisposition to working with computer systems.

The converse can also be said to be true. If the organization has had a history of successful use of computer based support systems, then there is some organizational impetus that will "force" the user to make use of the available resources, even if they are unsuitable. Therefore we can say that if the organizational history was "previously successful" then it will increase the probability that more sophisticated systems will be implemented over the case where the history was "unsuccessful".

(2) Organizational Resistance to Change (Values:High resistance,Desire for change)

Today there are few organizations where there is a complete lack of experience with computer based systems. In these organizations the implementation of computer based systems would represent a major change. Since major changes may be stressful to the members of an organization, there would be a natural resistance to change in that organization. In organizations which already make use of Computer Based Information Systems, there can be a distinct traditional sense; even though they make use of technology, they are reluctant to do so. A value is placed on doing things the way they have been done and it is difficult to justify changing the status quo. However in some organizations, change is accepted or even encouraged and there is a willingness or eagerness to change and improve. In these situations change may be seen as a chance for self improvement, and rather than being resisted it is welcomed.

This variable could be interpreted as having two states, "high" resistance to change, (meaning that it will be more difficult to implement more sophisticated technology) and desire to change.

(3) Official Organizational Endorsement (Values: Endorsed, Little Support)

Many writers on organizational context suggest that an important factor affecting the success of implementation of an MIS is the official organizational support. This can take many forms: the organizational position of the MIS executive is sufficiently high in the organization, or the steering committee (or other executive information systems coordinating function) is placed high enough in the organization so that it can exert true pressure to have changes made and make available the necessary resources, or the executives themselves are supportive of the use of computer based support systems. Official endorsement then can have two effects: it can improve the organizational climate to make systems development more acceptable, or it can free up resources, to make it more possible. If there is a lack of official endorsement then the resources to make the project come to fruition will be more difficult to obtain and there may be some reticence on the part of other members of the organization to join in the development activity.

There are two values: "endorsed" and "little support".

(4) Organizational Environment (Values:Stable, Unstable)

This attribute is concerned with both the organization's internal and external environment. Research on information systems has shown that both these environments affect the implementation of IS in an organization. These factors could include the stability of the external environment, (for example the organization's market share, the industrial markets in which the organization competes), as well as the internal stability (stability of management, stability of process technology).

The postulate here is that organizations that face more uncertain environments will have more complex decision making tasks than those which face more stable environments, and in the more complex environments it will be more necessary to provide more sophisticated support systems because they will need not only better data, but better tools to manipulate and transform that data into information. The environment can therefore be operationalized as having two values "stable" and "unstable".

Case #4

You have been called into the Director of Personnel's office. There has just been an executive meeting based on a recent Human Rights hearing into allegations of systematic discrimination by your company. Although the Personnel system was one of the first information systems to be automated nearly fifteen years ago, it has changed little since then. Until the present Director of Personnel came in two years ago Personnel was regarded as the dumping ground for the old dinosaurs of the firm, whose sole ambition appeared to be to collect their pensions. Collectively they believed that if it works don't fix it, and as long as the roof hadn't caved in, it must still be working.

Joan Smith, the director greets you at the door. She is an energetic woman in her early 40's with an M.B.A. from a well known business school and a reputation for getting what she wants. You know she's done a great deal to move the Personnel Department into the 1980's by replacing the older managers with no background in Personnel, with younger, more innovative professionals who shared her desire to move ahead to the 1990's. They feel that the current systems are antiquated and efficiency will improve with more sophisticated systems support. "We're in trouble", greets you as you step inside.

" This company has really done a great deal to improve the opportunities for women and minorities over the last ten years. Now we are developing and implementing strategies to cope with a changing workforce, a marketplace that demands flexibility and adaptability from any company that wants to survive, in a high technology industry with product life cycles of about 3 years.

Fifteen years ago we employed a largely white male middle aged workforce working a forty hour week, and used overtime in peak demand periods, and layoffs in slack periods as a means of balancing labour supply against product demand. Today we employ a much younger, more highly skilled workforce , composed of caucasians, blacks, Asians, males and females. We have been developing policies to help us serve the changing needs of our workforce. We are implementing flexible work hours, work sharing, and less-than-full-time employment (aimed at both women who have young families and workers easing into retirement). We are developing an educational leave policy to help employees upgrade their skills without having to quit work. We have developed a plan which makes use of reduced work weeks to help reduce the effects of low demand periods. We will soon have some of the most progressive human resources policies. Despite this, in front of the Human Rights Commission, I couldn't prove that we don't discriminate using the reports generated by that antiquated monster you call an information system."

After a few moments of uncomfortable silence she continued. "I have the complete support of the rest of the Executive that our highest priority is to get a proper Human Resources Information System up and running. This will allow us to to ensure that we can work efficiently today, while proceeding with the implementation of our new policies. This is critical if we are to continue to respond to the changes in technology, while maintaining our skilled workforce, and attracting new workers as we grow."

"I will personally work with you in developing this system. I know that your track record in this company is poor, $d\that the albatross of a personnel system you have inherited has created tension between your systems group and my staff. However I feel that given my staff, who are eager to implement the policies that they've developed, and your staff, who are eager to replace the old system will have the drive to get the new system up and running in a hurry."

Questions on Case #4

(1) Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(2) If Joan Smith had not replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, so that the professional staff still believed "If it ain't broke, don't fix it". Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(3) Suppose Joan Smith had not replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, but she was the only executive in support of the programme, and she was too busy to get personally involved in the systems development. Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(4) Suppose Joan Smith had replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, but she was the only executive in support of the programme, and she was too busy to get personally involved with the systems development. Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

For the next four questions accept that your previous systems development efforts have been successful, and that despite the difficulties in working with an antiquated system the relationship between the systems department and the personnel department was positive,because they appreciated your efforts to work with them to overcome the limitations of the old system.

(5) Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(6) If Joan Smith had not replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, so that the professional staff still believed "if it ain't broke, don't fix it". Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(7) Suppose Joan Smith had not replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, and she was the only executive in support of the programme, and she was too busy to get personally involved in the systems development. Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(8) Suppose Joan Smith had replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, who still believed that the only way the department could improve was to put in place systems that worked, but she was the only executive in support of the programme, and she was too busy to get personally involved with the systems development. Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

For the next eight questions assume that you are working in a different firm, and that the technology in this firm isn't changing rapidly, if it changes at all. Furthermore the workforce composition has remained almost static, and there is little demand or need for re-education. The product demand is also reasonably constant. A good example of this type of industry is the coffin manufacturing industry. Joan Smith who is the director of personnel, has been embarrassed by The antiquated system in use, and as vacancies have occurred she has hired new professionals who are eager to modernize the system. The rest of the conditions are as described in the original case.

(9) Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(10) If Joan Smith had not replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, so that the professional staff still believed "if it ain't broke, don't fix it". Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(11) Suppose Joan Smith had not replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, and she was the only executive in support of the programme, and she was too busy to get personally involved in the systems development. Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(12) Suppose Joan Smith had replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, but she was the only executive in support of the programme, and she was too busy to get personally involved with the systems development. Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

For the next four questions accept that your previous systems development efforts have been successful, and that despite the difficulties in working with an antiquated system the relationship between the systems department and the personnel department was positive,because they appreciated your efforts to work with them to overcome the limitations of the old system.

(13) Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(14) If Joan Smith had not replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, so that the professional staff still believed "if it ain't broke, don't fix it". Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(15) Suppose Joan Smith had not replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements, and she was the only executive in support of the programme, and she was too busy to get personally involved in the systems development. Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

(16) Suppose Joan Smith had replaced the "old dinosaurs" of the personnel department with younger and more progressive replacements,and they still firmly believed that the only way to improve performance was to get a more modern support system. But Joan was the only executive in support of the programme, and she was too busy to get personally involved with the systems development. Would you find it preferable or desirable to describe this situation as SUPPORTIVE? As NON-SUPPORTIVE?

Factor II: Problem Space Complexity

The purpose of this model is to select the most appropriate method of supplying computer based support to decision makers. One factor that will affect which approach to take in developing a support system for a particular user is the level of problem space complexity. Here complexity is taken from the perspective of developing a support system for the user who is confronted by the given problem space. The problem space complexity factor will be assigned three levels:

Complex----------Implies that features of the problem space that the decision maker is faced with will make the task of developing a computer based support system complicated.

Moderate---------Implies that features of the problem space that the decision maker is faced with will make it somewhat difficult to develop a computer based support system.

Simple-----------Implies that the problem space that the decision maker is faced with present no major problems for developing a computer based support system.

There are six attributes which help to define this factor :

(1) Problem Uniqueness

(2) Problem Set Definition

(3) Data Resource Specification

(4) Range of Problems

(5) Interdependence of Decisions

(6) Problem Structure

ATTRIBUTE DEFINITIONS

(1) Problem Uniqueness (Values: Unique, Recurrent)

There are two considerations here, the first is whether the problems are unique or in some way ad hoc, or whether they are recurring with a reasonable frequency. The second is whether they are unique to one user or are common to a number of users in the organization.

If the problem space is likely to contain many unique or different problems, and if the problems will vary substantially between users, then it will be difficult to provide support to these users. This would be the extreme non-recurrent case.

If the problem space is likely to contain problems that are continuously occurring (such as budgeting) and are faced by a number of users then it will in general be simpler to provide support, all other things being equal.

(2) Problem Set Definition (Values: Multiple Problem Sets, Single Problem Set)

Besides characterizing how frequently problems tend to arise in the appropriate problem space we can characterize that space by how many different types of problems that it contains.

This factor is given into two values, the first (Multiple Problem Sets) represents the situation where the problem space is composed of elements of several different problem sets, i.e. finance, personnel, engineering, marketing.

The second (Single Problem Sets) represents a problem space that would contain only one problem set, i.e. a marketing problem set or a finance problem set.

(3) Data Resource Specification (Values: Complex, Simple)

This attribute represents the complexity of the data resources required by a particular problem, that is how many different data sources may be needed to help solve a given problem in the problem space and how well this set can be pre-specified.

This attribute has been assigned attribute values of complex and simple. A problem space requiring complex data resources is one where the data resources needed to solve particular problems cannot be pre-specified from a set of possible sources.

A problem space requiring simple data resources is one where there is a single data resource necessary to solve problems in the problem space and the data needed can be pre-specified.

(4) Range of Problems (Values: Wide Range, Narrow Range)

Even if a problem space can be said to encompass only one type of problem (one problem set) one may still be able to define a range of problems within the problem set. This is especially true in the case where the system is expected to grow and develop with the user.

Unless the support system can be fully developed initially, to provide support for the entire range of problems within the problem set it should be able to grow with the user. This attribute will be given two values: narrow range of problems, and wide range of problems.

A narrow range of problems in the problem space means that it is likely that a support system which will be able to aid the decision maker for all the possible problems he will face could be developed simply, all other things being equal.

A wide range of problems in the problem space means that it is likely that the system will need to grow and expand as the user encounters different problems, that is it will most likely not be possible to design the original system so that it can handle current and future problems.

(5) Interdependence of Decisions (Values: Pooled or Sequential, Reciprocal)

This attribute is commonly used in defining DSS and can be operationalized using by making use of the three valued taxonomy of Thompson. We will designate only two levels, since it is only reciprocal decisions that are thought to complicate the problem space.

Pooled Decisions are decisions which are made essentially independently whereas Sequential Decisions are decisions which are dependent upon decisions made previously by others in the organization, forming some sort of serial chain of decisions. However in both cases the input from other decision makers is not dependent on the decision to be made by this decision maker.

Reciprocal decisions are those decisions which are made in an environment where decisions made by one decision maker affect those made by other decision makers whose decisions in turn can affect his. This is more a form of group decision making.

(6) Problem Structure (Values: Structured, Unstructured)

This attribute is operationalized using a taxonomy based on the Simon ideas about managerial tasks. In much of the DSS literature these two types of tasks are referred to as Structured and Unstructured. The assumption is that the less structured the problem space, the more complex the task of designing a support system.

Structured Problems are those that can be analyzed a priori, and a set of steps to solve the problem or perform the task can be described.

Unstructured Problems are those that cannot be analyzed a priori and there is no one best way to carry out these tasks, and indeed the method of attacking these problems often changes during the problem solving process.

CASE #2

For this case please consider yourself to be the systems manager in a large firm with many government contracts. You have just been asked to provide a support system to the Director of Personnel.

Joan Smith, the director, has recently been asked to help to draw up the employment equity compliance plan for your company. She has no experience in this area, and hopefully this is the only time this type of plan will have to be developed.

The plan must show the composition of your workforce, the training programmes currently in place, address recruitment and selection, affirmative action, discuss union contract ramifications, and many other areas. It will use modeling and analysis tools and techniques from all of the personnel systems, as well as the strategic planning and forecasting, financial planning, production planning and other systems. Besides needing to work with many different types of problems (i.e. manpower planning, salary administration, labour relations, production planning etc.) the system must be prepared to cope with many different problems in each area. As an example the human resource planning section of the report might include sections on developing possible career paths for clerical staff (a predominantly female group), increasing the rate of flow of female professionals through the ranks to top positions, increasing the absolute number of female managers etc. Since you cannot say beforehand exactly what will be needed you will need to provide the capacity to provide the ability to handle as many problems as possible, in each area.

You will need to incorporate data from all the different corporate data bases as well as many of the department specific systems. You will also need to incorporate data from several external sources (i.e. Statistics Canada, Government surveys etc). Currently there are several affirmative action and employment equity initiatives underway in different departments. Joan Smith will need to interface with the managers in charge of those departments to get feedback on how well these plans are working and the managers can give some feedback on the feasibility of any recommendations she has developed. They may even be able to test some of these out on a limited scale. Although she has a longer planning horizon to implement the full plan, it is politically imperative that as much as possible be done quickly, even if it means some of the programs will be implemented in a recursive fashion.

Joan realizes that although she has been given general guidelines developing this programme will be different than anything she has ever done before, in that the final report will actually be shaped by the process of developing the report, including the attempts to implement parts of it during the study itself. She really don't know where she's going, or how to get there, or exactly what she'll need to get there.

First.Set of Changes to CASE #2

These changes are to be used for answering questions 2-8.

Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. Joan's job is to produce a series of specified reports for all the managers This means that she will not need to work interactively with the different departments and develop the report in a recursive fashion. However you will still need to provide access to many different types of analysis tools and techniques, from the different planning systems, to allow the problem to be studied from several perspectives. You will also need to provide access to data found in many different corporate data bases and several data sources in the personnel department. You may also need to provide access to external data sources. Because the reports are specified, although she will need to use different types of models, you know exactly which ones she will need to use, and they form a relatively small set, compared to the total number in use.

Second Set of Changes to CASE #2

These changes are to be used for answering questions 9-23

All the data that needed to produce the reports can be found in one centralized corporate data base. Furthermore it is possible to utilize a set of career development models from the manpower planning system for data analysis, rather than needing to use several methods of data analysis using models from several different support systems. It is now expected that along with the original report, it will be necessary to produce yearly updates, so that this can be considered to be an ongoing task, and as such it is not possible to specify which of the manpower planning models will be needed.

The rest of the case is the same as the original, Joan will still need to work interactively with the managers, you will need to provide access to many if not all of the manpower planning models to do the analyses necessary, and she still isn't exactly sure of all that is necessary to complete the task, which is highly unstructured.

Third Set of Changes to CASE#2

These changes refer to questions 24-29.

The data needed to produce the reports can be found in one centralized corporate data base. However it is still necessary to make use of models and analytical procedures form several different support systems. It will be necessary to produce quarterly reports along with the original report.

The rest of the case is similar to the original, in that Joan will still need to work interactively with the managers, and you will need to provide access to many if not all of the different models to do the necessary analysis, because she isn't exactly sure of all that is necessary to complete the task, which is highly unstructured.

Fourth Set of Changes to CASE#@

To be used for questions 30-35.

The difference between this block and the previous block is that all the data resides in a number of different data bases, some external to the company, but only manpower planning models and analysis techniques need to be used.

Questions on Case#2

(1) Would you find it preferable to describe this situation as one of: HIGH problem space complexity? As SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

For the next seven questions consider the second scenario:

(2) Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(3) Now consider that it is possible to define a small set of models from the manpower planning system that could be used for data analysis, rather than needing to use many models from different systems. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(4) Now consider that all data can now be found in one centralized database, but you still need to provide availability for several different types of analysis, and the report is a one time effort. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(5) Now consider that in addition to being able to define a set of models from the manpower planning system to be used for data analysis, all the necessary data for that analysis is stored in one centralized database. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(6) Now consider that, in addition to being able to define a small set of models from the manpower planning system that could be used for data analysis, Joan is now required to produce the initial report and a yearly update to this report, so that this becomes an ongoing task. However the data still reside in several different places. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(7) Now consider, that Joan is required to produce this initial report, and follow-up yearly update reports. The data can all be found in one centralized data base, but you will need to provide the availability of several different types on analysis, using tools found in different systems again. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(8) Now consider the situation where Joan will be required to produce an initial report as well as a yearly update to this report. The data will still be found in many scattered sources, and many types of analysis will have to be performed, although you still aren't sure about exactly what has to be done. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

These next eight questions refer to the third scenario:

(9) Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(10) Now you have found that Joan only needs to use a few of the models from the manpower planning system, and you she believes that the report will not change significantly over its life. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(11) Besides having discovered that Joan only needs to use a few of the models from the manpower planning system, Joan has also been told that only the final report will need to be implemented, and that the yearly updates will be used by the managers as a monitor of the performance of the company, so that there is no need to work with the individual managers during the study. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(12) Joan's job is now defined as producing a series of specified reports for all managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified and Joan won't need to work interactively with the different departments. Furthermore, you have discovered that Joan only needs to use a few of the models from the manpower planning system, for the life of the report. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(13) Joan's job is now defined as producing a series of specified reports for all managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified and Joan wouldn't need to work interactively with the different departments. Joan will still need to use most of the different types of models in the Manpower Planning System. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? MODERATE problem space complexity?

(14) Joan's job is now defined as producing a series of specified reports for all managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified. However, it is still necessary to develop the plan in an iterative fashion, so that Joan will need to interact continuously with the other managers. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(15) Joan's job is now defined as producing a series of specified reports for all managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified. However, it is still necessary to develop the plan in an iterative fashion, so that Joan will need to interact continuously with the other managers. Furthermore you have discovered that Joan only needs to use a few of the models from the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(16) Since only the final report needs to be implemented and the yearly reports will be used to monitor the situation it is no longer necessary to develop the plan in an iterative fashion. However Joan will still need to use nearly all of the models from the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

These next seven questions refer to the third scenario, except that you are once again only required to produce one report, so this is not an ongoing task.

(17) Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(18) Now you have found that Joan only needs to use a few of the models from the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(19) Besides having discovered that Joan only needs to use a few of the models from the manpower planning system, you have also been told that only the final report will need to be implemented, so that there is no need to work with the individual managers during the implementation of the report. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(20) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is your plan should include, have just been issued. This means that the task is now well specified and Joan won't need to work interactively with the different departments. Joan will however, need to use most of the models from the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(21) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified. However, it is still necessary to develop the plan in an iterative fashion, so that you will need to interact continuously with the other managers. Also, it is necessary to make use of most of the models in the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(22) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified. However, it is still necessary to develop the plan in an iterative fashion, so that Joan will need to interact continuously with the other managers. Furthermore you have discovered that you only need to use a few of the models from the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(23). Joan's responsibilities are well specified and she won't need to work interactively with the different departments. However you will need to provide access to most if not all the models from the manpower planning system, and due to a lack of government guidelines her job is still unstructured. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

These next six questions refer to the fourth scenario.

(24) Now you have found that Joan only needs to use a few of the models from each of the different planning systems. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(25) Besides having discovered that Joan only needs to use a few of the models from the different planning systems, you have also been told that only the final report will need to be implemented, so that there is no need to work with the individual managers during the implementation of the report. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(26) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is your plan should include, have just been issued. This means that the task is now well specified and Joan won't need to work interactively with the different departments. Joan will however, may need to use most of the models from the different planning systems. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(27) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified. However, it is still necessary to develop the plan in an iterative fashion, so that you will need to interact continuously with the other managers. Also, it is necessary to make use of most of the models in the different planning systems. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(28) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified. However, it is still necessary to develop the plan in an iterative fashion, so that Joan will need to interact continuously with the other managers. Furthermore you have discovered that you only need to use a few of the models from the different planning systems. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(29). Joan's responsibilities are well specified and she won't need to work interactively with the different departments. However you will need to provide access to most if not all the models from the different planning systems, and due to a lack of government guidelines her job is still unstructured. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

These next six questions refer to the fifth scenario.

(30) Now you have found that Joan only needs to use a few of the models from the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(31) Besides having discovered that Joan only needs to use a few of the models from the manpower planning system, you have also been told that only the final report will need to be implemented, so that there is no need to work with the individual managers during the implementation of the report. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(32) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is your plan should include, have just been issued. This means that the task is now well specified and Joan won't need to work interactively with the different departments. Joan will however, need to use most of the models from the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(33) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified. However, it is still necessary to develop the plan in an iterative fashion, so that you will need to interact continuously with the other managers. Also, it is necessary to make use of most of the models in the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(34) Joan's job is now defined as producing a well defined report for the managers. Government guidelines, which are quite specific in determining exactly what it is the plan should include, have just been issued. This means that the task is now well specified. However, it is still necessary to develop the plan in an iterative fashion, so that Joan will need to interact continuously with the other managers. Furthermore you have discovered that you only need to use a few of the models from the manpower planning system. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

(35). Joan's responsibilities are well specified and she won't need to work interactively with the different departments. However you will need to provide access to most if not all the models from the manpower planning system, and due to a lack of government guidelines her job is still unstructured. Would you find it preferable to describe this situation as one of: HIGH problem space complexity? SIMPLE (in terms of problem space complexity)? Of MODERATE problem space complexity?

FACTOR III...RESOURCE AVAILABILITY

The purpose of this model is to select the most appropriate method of supplying computer based support to decision makers. One factor that will affect which approach to take in developing a support system for a particular user is the level of resource availability. The resource availability factor will be assigned four values:

Null------------- Implies that it will not be possible to provide computerized support due to the lack of resources.

Simple System---- This means that the availability of resources will force the choice of more basic support systems. This will mean different things in conjunction with combinations of the other factors.

No Constraints--- This means that resources will not constrain the choice of strategy as suggested by the other factors.

DMSA------------- Implies that it will be necessary to supply a Decision Making System due to the lack of available, problem specific, human expertise.

There are six attributes which help to define this factor:

(1) Availability of Human Expertise

(2) Developer Problem Space Knowledge

(3) User Task Comprehension

(4) Availability of Technology

(5) Availability of Time to Develop Specific Systems

(6) Availability of Personnel to Develop Specific Systems

Attribute Definitions

(1) Availability of Human Expertise (Values: Available, Unavailable)

This attribute is meant to represent whether or not a capable human decision maker exists in the situation. If not then it will be necessary to supply a computerized decision maker. One of the arguments behind research to develop expert systems has been the scarcity of human expertise in certain fields and therefore the need to "clone" this expertise. It is operationalized as a dichotomous variable with values "available" and "unavailable".

(2) Developer Problem Space Knowledge (Values: Experienced, Inexperienced)

The higher the level of task comprehension by the user and the knowledge of the developer of the task of developing support systems for this particular problem space the greater the probability that the system can be pre-specified. If the opposite is true than the system will most likely need to undergo some form of evolutionary development. Developer Problem Space Knowledge is operationalized as having two values:

Experienced/Knowledgeable-- The developer has a good understanding of the problem space the user is facing either by having developed similar systems or by having some knowledge of the user's task because of previous training.

Inexperienced-------------- The developer has little understanding of the problem space faced by the user.

(3) User Task Comprehension (Values: Experienced, Inexperienced)

As with the previous variable it is important to understand the level of comprehension the user has of the use of computers in aiding the decision making process to determine the level of resources required to develop a support system. If the user is relatively computer illiterate, then it will take more time to develop a suitable support system for that user. This attribute has the values:

Experienced/Knowledgeable--- The user has a good understanding of the use of support systems in this particular problem space either from experience with previous projects or by having had some formal training in the field.

Inexperienced -------------- The user has little understanding of how a computer based system might be useful, or of systems development.

(4) Availability of Technology (Values: Available, Unavailable)

Operationalized as either appropriate technology being "available" or "unavailable" at a cost beneficial price for a specific project. Note that although the appropriate software might exist it may be too expensive for use in a particular situation. For example a framework package may exist that is suited for one particular application but it would require the purchase of specific hardware so that the total cost would be prohibitive. Or there may not be appropriate commercial software available for a particular application so that the system would need to be developed from lower level tools (Prolog, Lisp, a DBMS, a procedural language etc.) which would increase the cost and time required to develop the system.

(5)Availability of Time to Develop Specific Systems

(Values: Constraints, No constraints)

This attribute represents whether or not the time to develop a system is a major constraint. It is operationalized as "no time constraints" and "time constraints".

(6) Availability of Systems Personnel To Develop Specific Systems

(Values:Available, Low Availability)

This attribute measures whether or not there are sufficient support staff to provide aid to develop individual systems. It will be operationalized as "Development Staff Available" and "Low Staff Availability".

Case #3

You have just come from a meeting with Joan Smith, the director of personnel in your organization. She has requested that you begin development of a new personnel support system. She feels that it is imperative that the managers and professionals in the personnel department have computer aided decision support tools available to them, if they are to do their part in helping the company adjust and meet the demands of a changing world.

As usual it now up to you to try and figure out how to meet the "customer demand" for information systems. Its time to take stock and determine what the situation is in your own department. Your department is in relatively good shape to take on most major projects. You have recently begun to hire user-analysts to head development projects. Their knowledge of specific business areas allows them to develop a greater rapport with the end users, and to help to suggest areas that may benefit with automation. One of your best,John Anderson, has had eight years of experience in developing Human Resource Information Systems (HRIS). To go along with the user-analysts you have developed a staff of technical analysts and programmers who can work together as a team. While lacking in some of the organization background and communications skills of the user-analysts, the technical analysts all have a solid background in systems development and programming. Fortunately because two other projects are currently winding down, you will be able to assemble a solid team to develop the HRIS.

Because of the high priority of the project, you will be able to purchase the necessary hardware and software to develop the system. It looks like they will want some form of distributed processing with PC's on each individual's desk, as well as some form of networking to the mainframe. Since your group has just developed a system for the production management section you have site licenses for some of the necessary software tools, and a good working relationship with an OEM, so that you feel that you have good access to the necessary hardware and software.

The other resources that you feel are critical for developing a system are time and educated users. You can't develop systems overnight, no matter who the user is. Furthermore, if the users aren't sure about what they need and aren't aware of what a system can do for them, the chances are the system they get won't be what they want. Here again you seem to be very lucky. Joan is a no-nonsense type, but she realizes that she's better off having something done right the first time, and if you give her a reasonable schedule, and can defend the due dates, she'll give you the time to do it right. She's been involved with systems development efforts before, as have some of her rising stars, so that they have a good idea of what they want, and the level of effort it will take to develop it. You feel confident that you can put together a good user lead development team.

First Modification to Cases #3

Consider the following situation: although Joan Smith is a no-nonsense type, she has never been involved in a major systems development effort before. She knows that she needs help, but isn't sure what the computer can do for her. Similarly her staff have experience with a major mainframe system, that has been in place for years. They have no experience with systems development, (as user representatives) and also have little idea of what a state of the art system could do for them. They are still supportive and if your development plan sounds reasonable you will be given the time and resources you need, but they are inexperienced and will need to be educated along the way.

Second Modification to Case#3

Consider the following situation: all the factors in the original case hold, that is Joan Smith and staff are enthusiastic and knowledgeable users of information systems, you have the programmers and analysts available to work on the project, and you have software available to help develop the necessary systems. There are no time constraints. However, instead of having an experienced user-analyst to head the team, you have no one available with experience in developing HRIS, and the team leader will be a new user analyst with no previous experience in this field.

Third Modification to Case #3

In addition to the lack of an experienced user-analyst you are faced with users who have no experience in developing computer based systems. Joan Smith and her staff are enthusiastic and believe that something has to be done, but they are not sure what. They have no previous experience in developing a computer base support system as user representatives, and have only worked with an old existing mainframe based system.

QUESTIONS

(1) Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(2) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(3) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. There was also a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(4) If there was no shortage of qualified programmers and analysts but there was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

For the next four questions consider that this is the first large-scale microcomputer based project that your organization will be undertaking. You have no site licenses for software, and no organizational experience in developing systems using microcomputer based software. That is, you have no already developed systems that you can modify for use in the HRIS, so that everything will have to be developed from scratch. Furthermore, your company has a policy of developing it own tailor-made systems, as opposed to purchasing packages, so you will be expected to develop most of your own software, which may include some programming in basic or another third generation language.

(5) Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(6) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(7) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. There was also a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(8) Suppose there was <u>no</u> shortage of qualified programmers and analysts but there was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

For the next eight questions please refer to the first modification to the case.

(9) Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(10) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(11) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts There was also a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(12) Suppose there was no shortage of qualified programmers and analysts but there was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

For the next four questions consider that this is the first large-scale microcomputer based project that your organization will be undertaking. You have no site licenses for software, and no organizational experience in developing systems using microcomputer based software, that is you have no already developed systems that you can modify for use in the HRIS, so that everything will have to be developed from scratch. Furthermore, your company has a policy of developing it own tailor-made systems, as opposed to purchasing packages, so you will be expected to develop most of your own software, which may include programming in basic or another third generation language.

(13) Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(14) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(15) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. There was also a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(16) Suppose there was no shortage of qualified programmers and analysts but there was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

For the next eight questions please consult the second modification to the case.

(17) Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(18) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(19) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. There was also a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(20) Suppose there was no shortage of qualified programmers and analysts but there was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

For the next four questions consider that this is the first large-scale microcomputer based project that your organization will be undertaking. You have no site licenses for software, and no organizational experience in developing systems using microcomputer based software. You have no already developed systems that you can modify for use in the HRIS, so that everything will have to be developed from scratch. Furthermore, your company has a policy of developing it own tailor-made systems, as opposed to purchasing packages, so you will be expected to develop most of your own software, which may include some programming in basic or another third generation language.

(21) Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(22) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(23) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts There was also a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(24) Suppose there was no shortage of qualified programmers and analysts but there was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

For the next eight questions please refer to the third modification to the case.

(25) Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(26) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(27) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. There was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(28) Suppose there was no shortage of qualified programmers and analysts but there was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

For the next four questions assume that this is the first large-scale microcomputer based project that your organization will be undertaking. You have no site licenses for software, and no organizational experience in developing systems using microcomputer based software. You have no already developed systems that you can modify for use in the HRIS, so that everything will have to be developed from scratch. Furthermore, your company has a policy of developing it own tailor-made systems, as opposed to purchasing packages, so you will be expected to develop most of your own software.

(29) Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(30) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(31) Suppose the situation were changed, so that the other two projects mentioned were not winding down, and there was a shortage of qualified programmers and analysts. There was also a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

(32) Suppose there was no shortage of qualified programmers and analysts but there was a need to develop the system "right away" because of the new equity legislation and the need to meet its reporting requirements. Would you find it desirable or preferable to describe the situation as one in which there would be NO CONSTRAINTS on the type of support system to be developed? Constraints which would allow only SIMPLE SYSTEMS to be developed? Constraints that for practical purposes would PREVENT the development of meaningful computer based support systems?

APPENDIX V

SAMPLE INSTRUMENT FROM THE THIRD PHASE OF THE VALIDATION PROCESS

" To be read by the researcher as part of the introduction"

A STUDY OF FACTORS AFFECTING THE CHOICE OF AN INFORMATION SYSTEMS DEVELOPMENT APPROACH

INTRODUCTION

This study is part of a research programme whose goal is to develop a model to aid in the selection of an appropriate approach for supplying computer based support systems for decision makers. In the initial phase of this research a model detailing a list of factors (and their defining attributes) which influence the selection of systems was developed and validated. In the next phase of the research programme an attempt was made to determine how the attributes describing each factor interacted to determine distinct factor values. This phase will attempt to match these factor values to situations where various approaches for developing support systems are appropriate.

Therefore, for the purpose of selecting the appropriate approach for developing support systems we are assuming that situations can be described in terms of the four factors in the model. We are attempting to try to associate different combinations of factor values with different approaches for developing support systems.

We have defined five generalized approaches which could be used to develop computer based systems for supporting decision makers. These are:

1) The Null Approach
2) The Systems Development Life Cycle Approach
3) The Prototyping Approach
4) The Decision Maker Centered Approach
5) The Decision Making Systems Approach

"Give the respondents the sheet of definitions for the different approaches"

The four factors identified in the first phase of the research are:

(1) User Participation in the Decision Making Process
(2) Problem Space Complexity
(3) Resource Availability
(4) Organizational Context

"Give the respondent the 2 sheets of definitions for the 4 factors."

Definitions of the Generalized Approaches to Supporting Decision Makers

Note that an approach is defined as consisting of both the final product (system) as well as the manner in which development took place.

Null Approach (NA)

No computer support.

System Development Life Cycle Approach (SDLC)

An information system that provides users with information, but little aid in analysis. It is developed using a systems life cycle approach, with analysis, design and implementation phases and with user participation in the process. The system focus is on collecting, organizing, storing and retrieving information. May have query facilities to allow for ad hoc requests or provision of new reports based on existing data.

Prototyping Approach (PA)

An information system that provides the users with information, but little aid in analysis. It differs from the SDLC in that it is developed in a recursive fashion, where the system is continuously growing and developing from an initially simple start utilizing continuous feedback from the users. It performs the same functions as the SDLC type system.

Decision Maker Centered Approach (DMCA)

A system which is designed to provide user support in all phases of the decision making process, providing the user with access to information, analysis tools and reporting facilities. It is developed with the end user in an evolutionary, participative fashion.

Decision Making System Approach (DMSA)

A decision making system which will produce a suggested decision for a decision ratifier. It will be developed with an expert, not the end user, in a participative evolutionary fashion.

DEFINITIONS OF THE FOUR FACTORS USED TO DESCRIBE SITUATIONS

Factor I: User Participation in the Decision Making Process

The purpose of the model is to select the most appropriate method of supplying computer based support to decision makers. One factor that will affect which approach to take in developing a support system for a particular user is the level of participation of the user in making the decisions. For this study USER PARTICIPATION is defined as the set of behaviors or activities performed by the users. This differs from USER INVOLVEMENT which is the psychological state of the user and represents the importance and personal relevance of the issue. Attributes used to determine the level of USER PARTICIPATION include the importance of the problem to the decision maker, whether or not the user sees themselves as a Decision maker or a decision ratifier, the level of discretion the user has in selection of tools, and the level of participation the user has displayed in the development of the support system. USER PARTICIPATION in the decision making process can take on one of three values:

Low------------- Low level of participation in the decision making process by the actual decision maker.

Indeterminate--- Intermediate level of participation in the decision making process by the actual decision maker.

High------------ High level of participation in the decision making process by the actual decision maker.

Factor II: Problem Space Complexity

A second factor that will affect which approach to take in developing a support system for a particular user is the level of problem space complexity. Here complexity is taken from the perspective of how complex is the task of developing a support system for the user who is confronted by the given problem space. Attributes which could increase the complexity of the problem space include the number and kinds of data resources, the number of different types of problems that the user is likely to face, whether or not the problem space is well structured, the possible evolution of the problem space,and the interdependence of the decision maker on with other decision makers. The problem space complexity factor can take on one of three values:

Complex---------- Implies that features of the problem space facing the decision maker will make the task of developing a computer based support system complicated.

Moderate--------- Implies that features of the problem space facing the decision maker will make it somewhat difficult to develop a computer based support system.

Simple----------- Implies that features of the problem space facing the decision maker with present no major problems for developing a computer based support system.

FACTOR III...RESOURCE AVAILABILITY

A third factor that will affect the choice of which approach to take in developing a support system is the level of resource availability. Resource availability will be taken in the most general sense of the term, and includes the experience of the user community with respect to systems development, the availability of time to develop specific systems, the availability of systems personnel to develop specific systems, the knowledge of this personnel of the particular user area, and the availability of technical resources to develop specific systems. The resource availability factor can take on one of four values:

Null------------- Implies that it will not be possible to provide computerized support due to the lack of resources.

Simple System---- This means that the availability of resources will force the choice of more basic support systems. This will mean different things in conjunction with combinations of the other factors.

No Constraints--- This means that resources will not affect the choice of strategy.

DMSA------------- Implies that it will be necessary to supply a computer-based Decision Making System due to the lack of available, problem specific, human expertise.

By definition, if the resource availability is such that you are constrained to providing only a DMSA, then it is necessary to use this approach. Similarly if the resource availability is such that that no significant computer based system can be supplied, (Null Approach) than the approach for supplying decision support has already been specified. Only if the availability of resources does not totally constrain the situation and uniquely determine the approach will the other factors come into play. Therefore the cases you will be presented contain only those situations where there are either NO CONSTRAINTS, or where SIMPLE systems are possible. PLEASE INDICATE IF YOU AGREE OR DISAGREE WITH THIS STATEMENT.

FACTOR IV: ORGANIZATIONAL CONTEXT

The fourth factor that will affect the choice of approach to take in developing a support system for a particular user is the Organizational Context. For this research a reduced set of organizational context variables will be presented, because it is believed that many organizational attributes directly affect the availability of resources and the issue of availability of resources is addressed separately. The attributes that have been used to describe this factor include the resistance to change in the organization, the level of organizational support for the development of systems, the history of systems development in the organization and the general environment of the organization. The Organizational Context factor can take on one of two values:

Supportive ----------- The organizational context is conducive to the development of computer based systems.

Non-supportive-------- Factors in the organizational context will hinder the development of computer based support systems for decision makers.

"To be read to each subject as part of the introduction of the questionnaire"

QUESTIONNAIRE

For each situation you will be asked to rate your preference for using each of the systems development approaches, on a scale of 0-100. On this scale 100 means that a particular approach is completely preferred in this situation, 0 meaning that it is completely inappropriate, or that you have no desire whatever for using this approach. Since it is possible to have a significant preference for more than one approach in any given situation, the sum of your responses may total more than 100. However, since the list of alternatives is thought to include all significant alternatives, you should have significant preference for at least one of the various approaches in all situations, so your responses should total to at least 100 in every situation.

It is assumed that if an approach X is given a higher value than another approach Y in a particular situation, then you would prefer to use approach X in that situation. Similarly it is assumed that if approach X is given a value of 25 in one situation and 50 in a second situation, you have roughly doubled your preference for approach X in the second situation, with respect to the first situation.

To help you keep track of the factor values you will be given a card listing the factor values represented by each situation. At all time feel free to consult your previous answers, since you may wish to adjust any of these at any time, or to use these to help to determine your present answer.

For this case please consider yourself to be the systems manager in a large firm with many government contracts. You have just been asked to provide a support system for the Director of Personnel, who has recently been asked to help to develop and implement an employment equity compliance plan for your company. On your way to your first meeting you start to take stock.

Joan Smith, the director is an energetic woman in her early 40's with an M.B.A. from a well known business school and a reputation for getting what she wants. She believes that a "Hands-Off" decision making style similar to that attributed to President Ronald Reagan, would not be responsible. She believes that as a decision maker you must do more than accept or reject the decisions that your subordinates have made. She believes that if you are going to be responsible for a decision, you need to know the background behind it, where the data came from and what the alternatives were. In other words you need to "work through the numbers", yourself. This project represents one of the biggest challenges that she has faced, and given its importance, and the way she regards her role as a decision maker you expect her to exhibit a high level of participation in the decision making needed to develop and implement the report.

Before Joan joined the company two years ago, Personnel was regarded as the dumping ground for the old dinosaurs of the firm, whose sole ambition appeared to be to collect their pensions. Collectively they believed that if it works don't fix it, and as long as the roof hadn't caved in, it must still be working. You know she's done a great deal to move the Personnel Department into the 1980's by replacing these older managers who had no background in Personnel, with younger, more innovative professionals who shared her desire to move ahead to the 1990's. They feel that the current systems are antiquated and efficiency will improve with more sophisticated systems support. The priority assigned to this project indicates that the executive agrees that the current systems will not be adequate for the task and developing a support system has their support. With both the support staff and management behind Joan, the organizational environment will be supportive.

"We're in trouble", greets you as you as you enter her office.

" This company has really done a great deal to improve the opportunities for women and minorities over the last ten years. Now we are developing and implementing strategies to cope with a changing workforce, a marketplace that demands flexibility and adaptability from any company that wants to survive, in a high technology industry with product life cycles of about 3 years.

We have recently been asked to develop and implement an employment equity plan. The plan must show the composition of our workforce, the training programmes currently in place, address recruitment and selection, affirmative action, discuss union contract ramifications, and many other areas. It will use modeling and analysis tools and techniques from all areas of Personnel, as well as the strategic planning and forecasting, financial planning, production planning and other departments.

I will need to make use of information from several different sources. Those that come to mind include the different corporate data bases, some of our departments own systems,as well as several external sources (i.e. Statistics Canada, Government surveys etc).

I have the complete support of the rest of the Executive that our highest priority is to get a proper Human Resources Information System (HRIS) up and running. This will allow us to to ensure that we can work efficiently today, while proceeding with the implementation of our new policies, and remain in

As usual it now up to you to try and figure out how to meet the "customer demand" for information systems. Your department is in relatively good shape to take on most major projects. You have recently begun to hire user-analysts to head development projects. Their knowledge of specific business areas allows them to develop a greater rapport with the end users, and to help to suggest areas that may benefit with automation. One of your best,John Anderson, has had eight years of experience in developing Human Resource Information Systems (HRIS). To go along with the user-analysts you have developed a staff of technical analysts and programmers who can work together as a team. The technical analysts all have a solid background in systems development and programming. Fortunately because two other projects are currently winding down, you will be able to assemble a solid team to develop the HRIS.

Because of the high priority of the project, you will be able to acquire the necessary hardware and software to develop the system. The other resources that you feel are critical for developing a system are time and educated users. You can't develop systems overnight, no matter who the user is. Furthermore, if the users aren't sure about what they need and aren't aware of what a system can do for them, the chances are the system they get won't be what they want. Here again you seem to be very lucky. Joan realizes that she's better off having something done right the first time, and if you give her a reasonable schedule, and can defend the due dates, she'll give you the time to do it right. She's been involved with systems development efforts before, as have some of her rising stars, so that they have a good idea of what they want, and the level of effort it will take to develop it. Overall you feel that the availability of resources will present no constraints to the construction of the best support system.

To review, the situation as you see it.

(i) the problem of supplying a support system to help in the development and implementation of an employment equity compliance plan will be complex, because it involves incorporating several types of models for data analysis, several different data sources to help the decision maker with a problem that is not well structured, since there have not been comprehensive guidelines issued, and this is your organizations first venture into this area.

(ii) While one never has unlimited access to resources it appears that you will be given the time, technology, and staff (including and a user analyst with HRIS experience) necessary to implement whatever approach to developing a support system that you feel is best.

(iii) The organizational context appears to be very supportive, in that the prospective users are experienced in the use of HRIS and feel that there is a significant need for a new computer based support system, and the executive have endorsed the project and given it a high priority.

(iv) After the system is implemented Joan Smith, the prime USER of the system should display a high level of user participation in the decision making processes in producing and implementing the report, because of both the inherent importance of the project itself, and how she views her role as a hands on decision maker.

"The questions are to be asked by the interviewer who will present the appropriate reminder card to the subject with each question and record the answers in full view of the subject"

QUESTIONS

1) Given the list of five systems development approaches, on a scale of 0 to 100 please indicate your preference for using each approach. Note that 0 means you would not recommend the use of a particular approach, and 100 means that you are completely in favour of using that particular approach. What is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

2) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

3) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

For the next three questions the situation is similar to the original except that Joan's natural decision making style is that of a decision ratifier instead of a hands on decision maker. A decision ratifying style implies that she likes to review the decisions or suggestions of her subordinates, and then agree or disagree with them. (Note that for this type of decision making role to exist for extended periods of time she would normally agree with her staff, or either they would leave out of frustration, or she would need to replace them). Because the problem is still of great importance to Joan in that the company has made the development and implementation of an employment equity plan a priority and she is personally committed to this project. This means that she will probably display a moderate level of participation in the decision making processes involved in implementing the report, despite its inherent importance.

4) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

5) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

6) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

The next set of nine questions are the same as the last except that Joan has not been able to convince the rest of the executive that the employment equity plan has a high priority and because of the problems you have inherited, the relationship between your group and the personnel department has deteriorated. This historical lack of success and the lack of official endorsement lead you to downgrade your assessment of the Organizational Context to unsupportive. First let us consider the situation where Joan's decision making style is that of a decision maker rather than a decision ratifier and she considers the development and implementation of the plan to be of major importance, so that her participation in the development and implementation will likely be high.

10) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

11) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

12) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

For the next three questions the situation is similar to that of the previous three except that Joan's natural decision making style is that of a decision ratifier instead of a hands on decision maker. A decision ratifying style implies that she likes to review the decisions or suggestions of her subordinates, and then agree or disagree with them. (Note that for this type of decision making role to exist for extended periods of time she would normally agree with her staff, or either they would leave out of frustration, or she would need to replace them). Because the problem is still of great importance to Joan, that is she is personally committed to this project she will probably display a moderate level of participation in the decision making processes involved in implementing the report.

13) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

14) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

15) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

For the next three questions, consider that Joan still is trying to maintain the decision ratifier role however, she doesn't consider the development and implementation of the employment equity report to be of particular importance. Her reasoning is that the company is in general compliance with the governmental guidelines, so it is only a matter of fine-tuning current programs and then completing the paperwork to demonstrate this compliance. She has convinced the executive of this as well. You now are sure that she will display a low level of participation in the decision making processes involved in the development and implementation of the report.

16) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

17) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

18) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

For second set of 18 questions consider that as a systems manager you have resource constraints. although Joan Smith and her department still represent experienced and knowledgeable users, and they are willing to work with you and give you the time you need to develop the system, you have serious staff constraints. You have a severe shortage of experienced programmers and technical analysts, and because you have not done any major systems development in the HRIS area in a long time you have no one with experience either as a project leader in developing HRIS or even as a user analyst in the Human Resources field. Furthermore because of a company policy you have typically developed your own systems from scratch (i.e. Cobol programmes). Thus you can't rely on the use of user friendly 4GL's to help out. All in all you feel that although you will be able to develop something for Joan, it will be limited to a more simple or basic no frills system then she would prefer. Other than this the original conditions will apply.

19) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

20) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

21) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

For the next three questions the situation is similar to the previous one except that Joan's natural decision making style is that of a decision ratifier instead of a hands on decision maker. A decision ratifying style implies that she likes to review the decisions or suggestions of her subordinates, and then agree or disagree with them. (Note that for this type of decision making role to exist for extended periods of time she would normally agree with her staff, or either they would leave out of frustration, or she would need to replace them). Because the problem is still of great importance to Joan in that the company has made the development and implementation of an employment equity plan a priority and she is personally committed to this project. This means that she will probably display a moderate level of participation in the decision making processes involved in implementing the report, despite its inherent importance.

22) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

23) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

24) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

For the next three questions, consider that Joan still is trying to maintain the decision ratifier role however, she doesn't consider the development and implementation of the employment equity report to be of particular importance. Her reasoning is that the company is in general compliance with the governmental guidelines, so it is only a matter of fine-tuning current programs and then completing the paperwork to demonstrate this compliance. She has convinced the executive of this as well. You now are sure that she will display a low level of participation in the decision making processes involved in the development and implementation of the report.

25) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

26) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

27) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

The last set of nine questions are the similar to the previous set except that Joan has not been able to convince the rest of the executive that the employment equity plan has a high priority and because of the problems you have inherited, the relationship between your group and the personnel department has deteriorated. This historical lack of success and the lack of official endorsement lead you to downgrade your assessment of the Organizational Context to unsupportive. First let us consider the situation where Joan's decision making style is that of a decision maker rather than a decision ratifier and she considers the development and implementation of the plan to be of major importance, so that her participation in the development and implementation will likely be high.

28) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

29) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

30) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

For the next three questions the situation is similar to that of the previous three except that Joan's natural decision making style is that of a decision ratifier instead of a hands on decision maker. A decision ratifying style implies that she likes to review the decisions or suggestions of her subordinates, and then agree or disagree with them. (Note that for this type of decision making role to exist for extended periods of time she would normally agree with her staff, or either they would leave out of frustration, or she would need to replace them). Because the problem is still of great importance to Joan, that is she is personally committed to this project she will probably display a moderate level of participation in the decision making processes involved in implementing the report.

31) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

32) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

33) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

For the next three questions, consider that Joan still is trying to maintain the decision ratifier role however, she doesn't consider the development and implementation of the employment equity report to be of particular importance. Her reasoning is that the company is in general compliance with the governmental guidelines, so it is only a matter of fine-tuning current programs and then completing the paperwork to demonstrate this compliance. She has convinced the executive of this as well. You now are sure that she will display a low level of participation in the decision making processes involved in the development and implementation of the report.

34) Given the problem space is complex because it involves incorporating several types of models for data analysis, and the use of several different data sources to help the decision maker with a problem that is not well structured, (there have not been comprehensive guidelines issued, and this is your organizations first venture into this area) what is your preference for the Null Approach? The Systems Development Life Cycle Approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

35) Given that the government has now issued a set of guidelines for the development and implementation of the equity plan, so that you know exactly which of the Manpower Planning models will be used to analyze the data we could say the problem space complexity was only moderate. What is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

36) Given that you have also discovered that all relevant data is stored in one corporate data base so that the Problem Space Complexity can really be considered to be simple what is your preference for the Null Approach? The SDLC approach? The Prototyping Approach? The Decision Maker Centered Approach? The Decision Making Systems Approach?

"These will be cut into cards with one question per card and shown to the subject in conjunction with the appropriate questions"

QUESTION #1

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #2

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #3

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #4

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #5

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #6

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #7

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #8

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #9

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE .

QUESTION #10

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #11

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #12

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #13

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #14

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #15

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #16

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #17

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: NO_CONSTRAINTS
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #18

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE

QUESTION #19

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #20

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #21

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #22

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #23

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #24

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #25

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #26

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #27

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: SUPPORTIVE

QUESTION #28

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #29

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #30

USER PARTICIPATION: HIGH LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #31

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #32

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #33

USER PARTICIPATION: MODERATE LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #34

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: COMPLEX
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE

QUESTION #35

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: MODERATE
RESOURCE AVAILABILITY: SIMPLE OR BASIC

QUESTION #36

USER PARTICIPATION: LOW LEVEL OF PARTICIPATION
PROBLEM SPACE COMPLEXITY: SIMPLE
RESOURCE AVAILABILITY: SIMPLE OR BASIC
ORGANIZATIONAL CONTEXT: NON-SUPPORTIVE