

AN EXPLORATORY STUDY OF  
MANAGER - DEVELOPED DECISION  
SUPPORT SYSTEMS

by

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## ABSTRACT

This dissertation uses two approaches to investigate managerial experiences and perceptions regarding the development and organizational use of decision support systems (DSS). It uses S.L. Alter's implementation methodology for successful DSS implementation to study the characteristics of twenty-one DSS developed by managers for managerial use. The study also questions managers regarding the present organizational use of computer-based decision systems and what managers perceive should be done.

For manager-developed DSS, all of the implementation risk factors and strategies identified by Alter are observed in the study; however, some are less relevant than others. Implementation problems associated with the related use of computer terminals and DSS language are rated the most difficult to overcome. Close behind are problems of developers' over-optimism, lack of project relevance and developers' commitment. Multiple users and need for funding support are found to be the easiest problems to overcome. Difficulty of model validation, a factor overlooked by Alter, also emerges as an implementation risk factor which affects DSS development. Implementation strategies aimed at gaining users' commitment and participation are less likely to be used, while the strategy of tailoring the development effort to suit the

user appears effective in coping with a broad spectrum of implementation problems.

Managers justify their development and time costs in terms of the insights gained from the modelling process. For the issue of organizational use and acceptance of computer-based decision systems, the results indicate a less than enthusiastic acceptance in respondent organizations at the present time and a gap between the present situation and what "should be done". Use of a DSS bridges part of this gap, but managers appear uncertain about how to make productive use of technical analysts and consultants.

A number of situational variables are identified to explain the incidence of implementation problems, the use of implementation strategies, and the gaps in present vs. desired use of computer-based decision systems.

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## CHAPTER I: INTRODUCTION

### 1.1 Overview of Decision Support Systems

#### 1.1.1 Historical Background

The term 'Decision Support Systems' first appears in the literature in the early seventies. It represents a shifting of the emphasis of Management Information Systems (MIS), as well as a broadening of its scope. While MIS concentrates on attacking and having its main impact on structured tasks where predefined decision rules and operating procedures exist, Decision Support Systems (DSS) focuses on supporting the decision processes of managers through flexible access to models and relevant information. The DSS approach emphasizes analysis of key managerial decisions; its goal is to improve the effectiveness of decision making rather than its efficiency. Rapid changes in computer technology interact to make the DSS approach a practical one. Examples of changes include user access to vast quantities of data, new data base management techniques and availability of computer systems at much lower costs than ever before.



The DSS approach also evolves from the field of operations research/management science (OR/MS). Like OR/MS, DSS incorporates the use of models as a tool for analyzing problems. In OR/MS, the impact has been mainly on structured problems (as compared with structured tasks in MIS) where it is possible to explicitly formulate a problem in terms of objectives and constraints and for which sufficient data can be collected. In DSS, the emphasis is on combining the power of computer-based analytical tools with managerial judgement to tackle semi-structured problems.

In this study, the label DSS refers to both single and multiple systems, but its application is obvious from the context in which it is used.

### 1.1.2 Characteristics of the DSS Approach

The principal characteristics of the DSS approach, noted by Keen and Scott Morton (1978), Alter (1980), and Sprague and Carlson (1982) are:

- that these systems can be designed specifically to facilitate decision processes (as opposed to making clerical transaction processing more efficient);

- that these systems should support rather than automate decision making;
- that these systems should be able to respond quickly to the changing needs in the environment and decision-making approach of decision makers, and
- that these systems have features that make them easy to use by non-computer people in an interactive mode.

The label DSS has been applied in the literature to three levels of hardware and software combinations. DSS which allow decision makers to deal with specific sets of problems form the first level; Sprague and Carlson (1982) refer to these systems as "Specific DSS." At the second level are "packages" of hardware and software with capabilities (for instance, in the form of command languages) to build specific DSS; these DSS are referred to as "DSS generators" or "DSS languages". The Interactive Financial Planning System (Execucom, 1979) is one example of a DSS language, and is used by managers whose specific DSS have been reviewed in this study. "DSS Tools" forms the third level to which the DSS label is attached; these packages allow development of DSS languages or specific DSS. The SPSS computer package (Nie et al, 1975) and the FORTRAN or APL programming languages are examples of DSS Tools. For this study, the label DSS, unless otherwise qualified, refers to specific DSS.

The key technological components of a DSS relate to the management of dialogue, data and models. "Dialogue" refers to the interface between the system hardware/software and the user; dialogue styles can vary from the menu approach (i.e. a list of options) through fill-in-the-blanks to a question-and-answer format. Data captured and extracted from a wide variety of sources (both internal and external to a firm) are used to create a DSS data base. Flexibility in manipulating this information is a necessary requirement for a DSS. The analysis and integration of the available data is handled by the modelling capability of DSS. Typically, this is accomplished by the use of building blocks and modelling facilities provided in DSS languages.

A taxonomy for DSS has been proposed by Alter (1977) in which a DSS is categorized in terms of its action-orientation. In this view, a DSS can be categorized in one of seven types; ultimately, all DSS are either data-oriented or model-oriented. While this taxonomy has been criticized by Welsch (1980) for its orientation, a recent study by Grindlay et al (1981) confirms its validity for a Canadian sample.

### 1.1.3 Participants in DSS Development and Use

The participation of technical and managerial people in DSS

development and use can be quickly appreciated by casting them in specific roles. First is that of the manager or user; this is the person faced with the problem being tackled via a DSS. The second role is that of an intermediary, a person who helps the user; this person is drawn (depending on the situation) from a clerical or staff specialist position. The third role is played by the DSS builder who puts together the DSS, using for instance a DSS language. This role bridges the managerial and technical perspectives of DSS development. The technical contribution is required to provide added capabilities in data bases, analytical models and input-output formats, as well as to maintain the overall efficiency of the computer system being used. Each role may involve more than one person, or one person may perform more than one role.

#### 1.1.4 Development and Implementation of DSS

In the emerging field of Decision Support Systems, there is still an absence of fundamental theory regarding decision making and decision support. Issues of DSS development and implementation are thus frequently stated in terms of the more familiar disciplines of MIS and OR/MS. Keen (1978, p. 189), in addressing strategies for developing DSS, notes that "... for a system that automates a well-defined procedure with few organizational interdependencies, design is the key issue; for

a DSS, which explicitly focuses on management processes and which aims at changing procedures and concepts, implementation may be far more complex than the formal design process." MIS and OR/MS take very different perspectives on implementation. Successful implementation of a DSS makes imperative the need to consider all of the perspectives rather than the adoption of a single viewpoint.

The MIS approach to development and implementation has been mainly based on project management techniques, calling for a highly structured organization of the systems development effort. Its application has been successful in the development of structured transaction processing systems. This structure is quite unlike that found in the uncertain DSS environment, which calls for innovation and involves systems which never existed before.

Until recently, management science has virtually ignored most issues of implementation. Lucas (1975) reports on one survey of the application series of Management Science from January 1971 to June 1973 covering 150 articles on management science applications. Of the models reviewed, less than three percent had been implemented, i.e. used more than once. However, the recent combination of management science techniques with a behavioural science approach has focused on the process of implementation by considering the context of information

systems in terms of their design as well as use.

The term "implementation" applied to DSS produces different answers depending on the perspective of the responding individual. From a technical viewpoint, it represents completion of the software development and testing, and turning over of the "package" to the user. The system is considered implemented according to this viewpoint even if the user never actually makes use of it. From a user viewpoint, the "use" aspect of DSS is crucial to its implementation, since the user does not have to use a DSS unless he feels it will be of real value to him. The attention paid to a manager's needs, attitudes and abilities, as well as the organizational context and significance of the decision, are thus seen to be key factors in ensuring successful DSS implementation.

The implications for DSS development are that the design, implementation and evaluation steps are more closely interwoven than in either MIS and OR/MS applications.

The success of an implementation effort is difficult to quantify. No one variable has yet been identified which captures the degree of implementation success; researchers have thus pursued the identification of multiple-attribute measures of success. Generally, these measures are grouped in term of the characteristics of (1) the decision maker (2) the decision

making environment (3) the implementation process and (4) the DSS itself. The relative importance of any one measure appears to be situation-specific.

#### 1.1.5 Problems in Development and Operation of DSS

Alter (1980) identifies five categories of problems that can reduce the effectiveness of a DSS. These are technical problems, data problems, conceptual design problems, "people" problems and "fundamental limitations."

Technical problems arise from constraints of available technology as well as from inadequate or malfunctioning systems.

Data problems appear in two forms: those due to the nature of the data itself, and problems associated with the "feeder" role. Data problems of the first type include incorrect or unavailable data or excessive data requirements. The feeder role problem arises from the situation where the data required by a manager is provided by a person from another organizational unit. The "feeder" may not derive any personal benefit from giving information or may have fears of losing autonomy.

Conceptual design problems represent a class of nontechnical problems, which manifest themselves in two forms: problems

related to assumptions concerning people, and those related to software and modelling. The first type of problem is typically one of overoptimism among system designers that non-computer people will "figure out how to use computerized systems to solve their business problems." (Alter 1980, p. 133) As for problems related to software and modelling, these manifest themselves in three forms. The first is one of designing systems which become obsolete or inflexible, for example, in the face of organizational change. The second is one of attacking the wrong problem or one that is not oriented to the decision processes that actually exist in the organization. The third is one of "attacking the easy problem". Typically, controllable variables are treated in the model as exogenous, i.e., determined outside the model, and thus give rise to fixed and unrealistic assumptions.

For people problems related to DSS, it is often difficult to decide whether a particular behaviour or opinion is a "people problem" or a rational response to shortcomings of the system. People problems generally manifest themselves through the disuse and misuse of computer systems.

The category of "fundamental limitations" describes problems which constrain the types of systems which can be built. One example of such a problem is the lack of an explicit model of managerial decision processes, resulting in an inability for



models to draw inferences.

The problems identified above are manifestations of what Alter (1979) refers to as implementation risk factors. A risk factor can be viewed as a type of deviation from an ideal situation which acts to reduce the success of an implementation effort. Alter identifies eight such implementation risk factors; histories of DSS development efforts encountering them are "cluttered with high levels of discouragement and exasperation." (Alter 1980, p. 157)

#### 1.1.6 Strategies for Effective DSS Development and Implementation

The traditional approaches (from MIS and OR/MS) to systems development and analysis have proven ineffective in the DSS environment. A major contributing factor is that functional requirements of a DSS are not known in advance. The approaches which have been used with success (Sprague and Carlson 1982, p. 15) emphasize iterative design and an adaptive process. Unlike MIS, DSS specifications are never frozen -- they evolve with the user's increased understanding of his problem.

One approach to successful DSS development and implementation is "prototyping". The notion of building a prototype is familiar to all engineers. It is an accepted method for trying out new designs prior to commercial production. In DSS development, prototyping has been proposed as a way of allowing the user to influence system design before and after implementation. According to Earl (1982, p. 40),

"Prototype systems are simplified, flexible systems or routines used for exploration and experimentation. They are designed and written quickly, and thus may be crude and rough. Prototypes test alternative designs through live operation; thus they are continually amended, growing in complexity over time, with reliability perhaps sacrificed for flexibility. Once the prototype has served its experimental purpose, it will be replaced by a robust, now hopefully viable system."

Prototyping is one of several strategies identified by Alter (1979) for dealing with the implementation risk factors or their related problems. These strategies can be grouped into four general categories: dividing the project into manageable pieces, keeping the solution simple, developing a satisfactory support base, and meeting user needs and institutionalizing the system. Alter (1980, p. 165) cautions that "as in any decision, the choice of strategies will be based on a series of considerations, such as resource requirements, likelihood of success, and situational limitations of each of the strategies."

## 1.2 Problem Statement and Significance

### 1.2.1 Problem Statement

A decision support system is defined in this study as an interactive computing system supporting the decision processes of managers with flexible access to models and relevant information (i.e. data bases, subjective inputs, etc.). This research is an exploratory study of decision support systems developed by managers for their own use.

The study tests a number of hypotheses arising from Alter's implementation risk analysis methodology, and assesses the influence of a number of organizational, managerial and project-related variables on the success of DSS development. Determining the gap between what is being done now in respondent organizations and what should be done, and use of DSS to bridge this gap, is also included in the scope of the research study.

### 1.2.2 Purpose and Significance of Study

To date, most computer-based decision systems in use have been designed by technical specialists for use by managers.

Research data on DSS development and implementation has been primarily obtained from the environment where managers are users of DSS but not developers. A purpose of this study is to examine the characteristics of manager-developed DSS. A second purpose is to assess the present usage and acceptance of computer-based decision systems such as DSS in organizations, and to question managers on what should be done.

This study is significant in its contribution of research results in the relatively unexplored area of managers developing DSS for their own use. It tests hypotheses arising from Alter's implementation risk analysis methodology. If these hypotheses are supported, it serves to extend Alter's methodology to a new environment -- the environment of managers as builders and users. If rejected, it identifies the need for additional research.

Situational variables which could influence the development of DSS are examined from a managerial perspective when the managers are not simply users (as is the more common situation) but also system developers. The results from this study can be used by managers developing DSS either in a prescriptive or a diagnostic mode.

### 1.3 Areas of Concern

This study investigates two sets of questions. The first set concerns the usage and acceptance of computer-based decision systems (CBDS) in respondent organizations. The issues are analysed under three scenarios: the present state, the desired state, and a third state which assumes that a DSS facility is supported for organizational use. The use of a DSS approach in bridging the gap between the present and desired states is examined from the perspective of managers who have developed a DSS.

The second set of questions pertain to the experiences of managers who have developed and used a DSS. The issues raised relate to the likelihood of implementation problems and strategies identified earlier by Alter (1979) being encountered in manager-developed DSS.

#### 1.3.1 Implementation Problems

This research study sets out hypotheses for the implementation problems associated with risk factors identified in Alter's methodology. These problems may not be present in all phases of system development, but they pose a risk to the successful implementation of a DSS.

The implementation problems examined are:

- (i) Non-existent or unwilling users.
- (ii) Multiple users or implementors, causing communication problems.
- (iii) Multiple users or implementors, leading to an inability to incorporate multiplicity of interests.
- (iv) Overoptimism among system designers and users during some phase of development.
- (v) Lack of motivation during some phase of development.
- (vi) Requests for funding (monetary or computer resources) denied, i.e. lack or loss of support.
- (vii) Lack of experience with DSS language, leading to mistakes.
- (viii) Technical problems with computer system hardware or software.

### 1.3.2 Implementation Strategies

Alter identifies a number of implementation strategies for use in offsetting implementation problems. The strategies considered in this study are as follows:

- (i) use prototypes.
- (ii) use an evolutionary approach.
- (iii) develop a series of tools.
- (iv) be simple.

- (v) hide complexity.
- (vi) avoid change.
- (vii) tailor systems to people's capabilities.
- (viii) obtain user commitment.
- (ix) obtain user participation.
- (x) sell the system.

The research study explores the existence of additional implementation problems and strategies, and the significance of situational variables in the manager-developed DSS environment which have not been previously reported in the literature.

A number of situational variables encompassing organizational, managerial and DSS project-related characteristics are tested for significance of relationship with use and acceptance of CBDS, implementation problems encountered, and strategies used.

#### 1.4 Research Methods Used in Dissertation

##### 1.4.1 Data Collection

The data collection phase is accomplished through use of structured questionnaires and personal interviews. It is

administered to 70 out of an enrollment of 84 MBA students at Simon Fraser University in Burnaby, B.C. These students are practising managers and professionals, enrolled in the University's executive MBA program. Of thirty-one managers in the sample who have completed courses in Operations Research and Management Information Systems, twenty-nine participate in this study. As part of the MIS course, these twenty-nine managers have learned to use a DSS software package. Also, they are required to select a problem of their choice (typically of significance to their own companies) for analysis and resolution. They then develop a computer-based model of the problem using the DSS software package. The development of a model is considered complete when managers determine that enough information has been obtained to resolve the problem at hand. The development effort in all cases is terminated at expiry of the allotted time (end of semester), or earlier if it becomes impractical to continue.

Thirteen managers develop DSS on their own while sixteen others are teamed in pairs to work on the same project -- a total of 21 DSS. The opportunity exists to extract information on the development of DSS models by intra-managerial groups. This particular grouping is typically to be found in firms examining planning problems, an application for which DSS have been found appropriate. The evaluation of success



or failure in a DSS development is made by each developer-user.

The structured questionnaire method is supplemented by personal interviews to obtain data of a descriptive nature pertaining to each DSS project. It is worth noting that the literature does not offer much information on the descriptive evaluation of DSS when the managers are also the developers of their systems.

A second group of 53 MBA students is available from those who have completed the Operations Research course, but not the MIS course and thus have not learned the use of a DSS language. Using a questionnaire approach (a subset of that used with the first group), 41 of this group provide data on the present status of computer-based decision systems (CBDS) in their organizations, and identify what it "should be" if respondent expectations are fully achieved.

The relatively small sample size of respondents can be justified in a number of ways. First, for an exploratory study of the type undertaken here, the population is expected not to be large since the phenomenon of managers developing DSS models is relatively new. Second, the uniformly high quality of the polled sample (by virtue of their academic and experiential background) is expected to produce reliable and useful data.

Chronologically, the DSS projects are completed by the end of April 1982. The data collection phase of the study is executed during September and October, starting with a pretest of questionnaire and interview questions.

#### 1.4.2 Data Analysis

The information collected from the questionnaire is coded for keypunching and input into the SPSS (Statistical Package for the Social Sciences) computer program. A variety of non-parametric tests, including cross-tabulation (for chi-squared tests), and one-way analysis of variance by ranks is performed. Non-parametric tests require fewer qualifications as to the nature of the distribution of the population from which the sample is drawn.

#### 1.5 Organization of the Dissertation

Chapter II reviews the literature relevant to this study. It traces the evolution of DSS, and notes the lack of a standard definition of DSS. The technological components of a DSS are identified and used in developing criteria for system design and feasibility. This is followed by a discussion of DSS

implementation issues. Problems and offsetting strategies associated with implementation are noted, along with situational variables which could influence the success of DSS implementation efforts. Alter's implementation risk analysis methodology offers a useful means of highlighting the relationship between implementation risks and strategies.

Chapter III describes the research problems as two sets of questions. The first set explores the current status and future potential for usage and acceptance of computer-based decision systems (CBDS) in respondent organizations. The second set reviews a number of manager-developed DSS. The development processes used in these DSS projects allow a testing of several hypotheses arising from Alter's implementation risk analysis methodology. A number of situational variables suggested by the literature survey as important to DSS development are examined for statistical significance in this sample of DSS.

Chapter IV describes the research methodology. The instruments and procedures for data collection are noted. The specific hypotheses being tested are formally stated. The non-parametric techniques used for analysis are described.

Chapter V discusses the results from the set of research questions which relate to the current status and future potential

in respondent organizations for computer-based decision systems (CBDS), including DSS. A combination of qualitative and quantitative assessment is used to highlight various issues which are important to responding managers.

Chapter VI addresses the manager-developed DSS examined in this study. Descriptive evidence is used to complement the statistical results. The conclusions from hypothesis testing of Alter's implementation risk analysis methodology, and tests for statistical significance of organizational, managerial and DSS development variables are presented.

Finally, Chapter VII represents an overview of the research study. The results of the study are interpreted in terms of conclusions and implications. The limitations of the study are noted, and possible areas for further research are suggested.

## CHAPTER II: A SURVEY OF RELEVANT LITERATURE

### 2.1 Introduction

This chapter presents the results of a literature survey conducted as part of this research study. The primary objective in undertaking this survey is to identify feasible approaches to the study of DSS development and implementation from a managerial perspective. DSS is viewed as a managerial tool for problem solving and decision making which has evolved from the fields of management information systems (MIS) and operations research/management science (OR/MS). In order to maintain the focus of this chapter on DSS, some of the literature survey results are presented separately as appendices. Appendix IV highlights some significant models for managerial problem solving which have been found useful in the development of computer-based information systems. Appendix V summarizes the results of the search of MIS literature related to the study area, while Appendix VI notes the significant developments in OR/MS which have influenced the direction of evolution of DSS.

The first part of this chapter covers the topics of definitions and foundations of DSS. It is noted that a definition of DSS has not yet been universally agreed upon; the foundations of DSS include considerations of DSS design criteria and feasibility, as well as those of successful implementation. This is followed by a review of various taxonomies proposed for DSS, and a summary of frameworks and methodologies which have been used or suggested for research in DSS development and implementation. Alter's methodology is highlighted, as it is central to this study. The last part of this chapter covers the findings of some recent research on DSS development and implementation.

## 2.2 DSS Definitions and Foundations

### 2.2.1 Evolution of DSS

The second half of the nineteen seventies has seen increased computer power delivered in the hands of the user. Technological improvements in computer hardware and software have resulted in the user being able to access extensive computer facilities via low cost terminals and communications networks with short turn-around times.

These achievements of technological and economic efficiencies in computer systems have been accompanied by a dramatic growth in the complexity and volume of information processed by organizations and individuals. Simon (1977) refers to this development as the third information revolution, following the earlier developments of the written language and the printed book.

As part of this growth in information processing, DSS has evolved as an approach which integrates the mechanized information processing power of the computer with the human elements embodying judgment and creativity of the user in a powerful man-machine system. The DSS approach has been particularly productive in support of managerial decision making involving relatively unstructured problems, such as strategic planning.

The textbooks on decision support systems by Keen and Scott Morton (1978) and Alter (1980) contain a number of case studies developed from operational DSS. The majority of the case studies are developed as part of doctoral studies; Alter (1975) reviews more than fifty DSS. Functionally, the applications are drawn from the management areas of finance, accounting, marketing, production, etc. Multi-function applications in corporate and strategic planning are also represented in large numbers.

### 2.2.2 Definition of DSS

There is no commonly accepted definition of the term "decision support system".

As Welsch (1980) succinctly states, "it is up to the individual researcher to specify the definition and boundaries which will be used in his or her research .... including too little has the danger of making the results too specialized, and so of little value; on the other hand, including too much has the danger of clouding the relationships, and so defeating the purpose of research". (p. 17)

The inductive nature of arriving at a definition for DSS is exemplified by the efforts of McCosh and Scott Morton (1978), who define DSS as a system "supporting the decision processes of managers with flexible access to models and relevant information". (p. 3)

Other researchers such as Keen (1976), Sprague and Watson (1976) expand on the "nonroutine" aspect of decisions by explicitly including unprogrammed or semistructured problems, requiring the query facility to be interactive, and the software to include a data base management system. As Welsch notes, these are just examples of defining specific boundaries



for a DSS. The boundaries of a DSS can be described in terms of its technological components and design criteria.

### 2.2.3 Components of a DSS

The technological components of a DSS are best described by its definition; they include:

- (1) the user or the decision maker and the advocate, if appropriate.
- (2) computer models.
- (3) a computer facility.
- (4) a communications facility, normally provided by a common carrier such as a telephone company.
- (5) data base.

### 2.2.4 Design Criteria for a DSS

The literature survey identifies certain characteristics of DSS which may form the design criteria for any DSS (see for example, Keen and Scott Morton (1978), Sprague and Carlson (1982), Bennett (1983)). The design criteria would include the following:

- (1) a DSS must be designed specifically to support managerial decision making, not to automate it.
- (2) a DSS must be interactive, for access to both models and data.
- (3) a DSS must have flexibility to satisfy the requirements of many types of managers, in a variety of functional areas and at a variety of managerial levels.
- (4) a DSS must be dynamic enough to allow its modelling and data capabilities to evolve with changing user requirements.

A common element in the above design criteria is that the capabilities of the manager and the computer are harnessed to produce synergistic results. The intuitive judgment of a manager cannot be easily programmed, while the calculating power of the computer are far beyond the abilities of the manager. Taken together in a DSS approach, each can make a valuable contribution and produce high payoffs from the decision making process. Those abilities that the system does not possess must be provided by the user to produce a powerful man-machine system.

There are two forms of variation in man-machine interaction which may appear in a DSS. The first arises from the type of requests and sequence of requests made by the user of the system, together with the manner in which the user makes use of the system responses.

The second form arises from the system, through the existence of alternate methods for solving a problem. This situation does not arise with a completely structured problem where there is a single way of finding a solution.

### 2.2.5 Successful Implementation of DSS

What constitutes a "successful implementation" of a DSS? Many researchers including Keen (1976) visualize implementation as a process, rather than a specific event. Thus there may exist different degrees of system implementation, along some continuum. Welsch (1980) in her doctoral study offers one such definition.

"A decision support system is regarded as successfully implemented

- (1) when it is in fact used by decision makers in making nonroutine decisions;
  - (2) when it has been internalized by them, that is, regarded by them as an integral part of their decision making process; and
  - (3) when the DSS function is institutionalized into the organization, that is regarded as a permanent fixture in the organization with continuing financial support."
- (p. 81)

The measurement of DSS implementation success has not been possible through one single index or variable. Rather, multi-attribute measures of DSS implementation success have been

proposed by researchers (see for example, Fuerst (1979)).

These measures can be generally grouped into four categories:

- (1) characteristics of the decision maker
- (2) characteristics of the decision making environment
- (3) characteristics of the implementation process, and
- (4) characteristics of the DSS.

The relative importance of any specific factor within each of these categories is, however, contingent on the specific environment in which the application is implemented.

Two approaches to DSS implementation which have yielded successful results involve the prototyping of DSS and the use of individuals referred to as advocates. Project management techniques have been used for quite some time in controlling systems development efforts for structured transaction-based information systems. However, these techniques which have worked well for building systems to fixed specifications have not proven themselves in the considerably more unstructured and evolving environment of DSS. Evolutionary and iterative processes such as "prototyping" have taken the place of project management. As Earl (1982) states,

"in response to the need for greater emphasis on design decisions, for more rigorous assessment of system performance and

for user opportunity to influence systems design before and after implementation, the idea of developing trial, simplified systems - or prototypes - arose. A system that was used, tried, and tested seemed more attractive than one with pristine sophistication. A climate of change and experimentation seemed more meaningful than sacrosanct rigidity." (p. 40)

In prototyping, the systems are built in small modules which are used by the decision maker to "learn" more about the problem being investigated. These modules may be maintained, rejected or modified depending on their contribution to the user's learning about the problem at hand. According to Asner and King (1981), this approach has been found "particularly valuable for decision support systems ... where there is significant uncertainty regarding the design cost or usefulness of the system." (p. 30)

The role played by advocates is another factor which has contributed to the acceptance, utilization and satisfaction with DSS (see Bean and Radnor, 1979). Various referred to as intermediaries, integrators and information transfer specialists, these individuals play a key technical and facilitative role in producing effective man-machine interaction in the use of DSS. The term "advocate" covers individuals who recognize the potential for a model, as well as those who train users in specific DSS and assist them in interpreting the system results. These individuals deal with conflicts between user-managers and technical analysts; these conflicts usually arise

from differences in their respective values, attitudes and behavioural norms.

The development of a transaction-based computer system is usually preceded by a study of its feasibility, to ensure cost-effectiveness and timely delivery to the user. Feasibility studies of DSS conducted along these traditional perspectives often produce results not conducive to DSS development.

#### 2.2.6 Feasibility of DSS

The feasibility of a MIS system is assessed commonly on the basis of technical, economic, operational and schedule considerations (Murdick, 1980). Applying the same itemized analysis to assess the feasibility of DSS, the requirements for technical, operational and schedule feasibilities are readily satisfied given suitable terminals, models, computer systems and access to advocates. The economic feasibility of a DSS in terms of costs vs. benefits is not so easy to establish. Costs can be reasonably estimated by adding up the cost figures for hardware, software, communications network and support personnel. The primary benefits of a DSS are in the value of the improvement in decision making, and "is the most difficult single factor to measure". (McCosh and Scott Morton, 1978, p. 23).

Organizations applying the conventional MIS cost-benefit analysis techniques to DSS have found little incentive to institute DSS development. The use of advocates and external consultants have been a primary influence in overcoming this barrier to DSS development; they have helped users to trust their DSS systems and have the feeling of being "in charge". Keen (1980b) refers to this as "psychological validation" of DSS.

### 2.3 Frameworks for the Study of DSS

#### 2.3.1 A Taxonomy for DSS

Alter's framework for categorizing DSS is based on "the degree of action implication of system outputs, i.e. the degree to which the system's output can directly determine the decision." (Alter 1980, p. 73).

Alter identifies a spectrum of generic operations that can be performed by a DSS as extending along a single dimension, ranging from being extremely data-oriented to extremely model-oriented. These operations include:

- (i) retrieving a single item of information.

- (ii) providing a mechanism for ad hoc data analysis.
- (iii) providing prespecified aggregations of data in the form of reports.
- (iv) estimating the consequences of proposed decisions.
- (v) proposing decisions.
- (vi) making decisions.

The DSS investigated by Alter (1980, p. 74) fall into seven reasonably distinct types:

- (i) File Drawer Systems allow immediate access to data items.
- (ii) Data Analysis Systems allow the manipulation of data by means of operators tailored to the task and setting, or by operators of a general nature.
- (iii) Analysis Information Systems provide access to a series of databases and small models.
- (iv) Accounting Models calculate the consequences of planned actions on the basis of accounting definitions.
- (v) Representational Models estimate the consequences of actions on the basis of models that are partially non-definitional.
- (vi) Optimization Models provide guidelines for action by generating the optimal solution consistent with a series of constraints.
- (vii) Suggestion Models perform mechanical work leading to a specific suggested decision for a fairly structured task.

The Alter taxonomy collapses the above DSS into data-oriented and model-oriented systems; Alter (1980) notes that: "Such a simplification loses a great deal of information, however, by grouping systems that differ in many significant ways."

(p. 74)



Alter (1980) concludes that his taxonomy is more useful for DSS than schemes proposed by Anthony (1965), Simon (1960, 1977) and Keen (1980b):

"For this sample of DSS's, none of these schemes seemed to be as useful as the one discussed above [Alter's] as a way of organizing the patterns that were observed. [Anthony's] "Decision perspective" had a problem, since systems used in short-run operational planning were often similar to longer-range planning systems in both mechanics and underlying concepts. [Simon's] "Problem type" was not useful because it was difficult to decide whether one business problem for which a computerized system could be used was more or less structured than another (especially since structure is in the eye of the beholder). Finally, the expected significance of [Keen's] interactive vs. batch distinction was diminished greatly in the many cases in which decision makers were not the hands-on users." (p. 74)

Welsch (1980), however, takes issue with the appropriateness of Alter's taxonomy:

"How can the highest level of DSS (i.e. suggestion models) be the one in which the computer takes over the entire decision process -- as if the DSS philosophy were to use the computer to replace the human in the problem-solving process? No, while the Alter framework would have been a good framework in the pre-DSS era, it fails to follow the true DSS philosophy to "support" the decision maker in his decision making efforts." (p. 40)

Keen (1979a) appears to have anticipated Welsch's objections:

"The key proposition is that a DSS exploits the benefits to be obtained from analytic methodologies and information technology by improving the marginal economics of effort ....

Decision Support will often choose to work well within the technical state-of-the-art and "package" standardized models. For example, an LP can be disguised as a simulation; to the user, the "system" is the software interface that manages the user-machine dialogue .... Building a DSS requires, above all, skills in designing humanized interfaces and a secondary ability to exploit any self-contained technique or product developed within the MIS or OR/MS fields." (p. 24)

Grindlay et al (1981) review Alter's taxonomy, and comment that: "not only is it useful for learning the types of systems which exist, but the taxonomy can help the system developer to focus on the key issues of the system on which he or she is working." (p. 33) They further study the appropriateness of Alter's taxonomy in a Canadian sample of 131 DSS. All of the Canadian DSS are found to fall into at least one of Alter's taxonomy classes and there are no empty categories; the conclusion is that "it appears then, that Alter's taxonomy is an appropriate tool for classifying Decision Support Systems." (p. 36)

### 2.3.2 DSS Research Frameworks

A framework essentially provides future researchers with a relevant context for the organization of their studies as well as in interpretation of results.

### Keen's Adaptive Framework

Keen (1980b) proposes an adaptive framework for investigation of decision support systems. The links between the technical and non-technical components of the DSS are identified respectively as the system, the builder and the user. The use of the term "adaptive" is central to Keen's DSS framework. He emphasizes: "The label "Support System" is meaningful only in situations where the "final" system must emerge through an adaptive process of design and usage." (p. 11) The concept of a "middle-out" design linking the user and the builder shifts the focus of the system development cycle from implementing one with fixed specifications (as in MIS) to "implementing an initial one that can then be firmed up, modified and evolved." The term "adaptive design" includes middle-out design techniques, and is a "method for beginning" rather than a "strategy for finishing." (p. 7)

### Little's Decision Calculus

Little (1970) summarizes as a decision calculus certain criteria for building models for managers. The decision calculus constitutes a strategy for model design as well as decision support and is defined as a "model-based set of numerical procedures for processing data and judgments to

assist managerial decision making." (p. B470)

Lodish (1981) notes that what distinguishes decision-calculus models from other OR/MS models is in their method of implementation, and in integration of the user into the model via his estimation of otherwise unavailable data.

#### 2.4 Building Decision Support Systems

Bennett (1983, p. 1) views the building of DSS as a process which includes "planning, design, development, testing and incorporation into the user's work." Since the functional specifications of a DSS, unlike those of a MIS, are usually not known in advance, DSS development calls for an adaptive and iterative approach to systems analysis and design. The length of the system life cycle for a DSS is of the order of a few weeks (rather than months or years as in MIS), involving frequent interaction between system builder and system user. As Sprague and Carlson (1982, p. 17) note, "the resulting changes in the development approach and the traditional view of the systems life cycle promises to be one of the important impacts of the growing use of DSS."

As to the orderly planning for DSS activity in organizations, Gulden and Arkusk (1982) propose five interrelated elements

(as continuums) to help decision makers formulate a strategy for the development of a DSS. These elements are: target market (i.e., customers or users), products (specific or general purpose DSS), customer support (through specialists or over the telephone), delivery technology (hardware and software tools) and management policy groundrules (for cost, project justification, etc.). The interaction of these elements leads to a "strategy profile", a way to visualize DSS strategy. Shrivastava (1982) considers the development of DSS for strategic ill-structured problems; he identifies four distinct patterns of strategic decision making in organizations, each of which have implications for DSS development for this class of problems.

Alter (1982) addresses the circumstances under which DSS can be developed and used directly by managers and professionals. "If a manager is to develop a DSS that performs the steps a DSS must perform, then the manager must know how to perform each of those steps .... The issue here is knowledge, not computer technology." (p. 110). Alter asserts that the knowledge requirements relate to the operation and use of a DSS, that "the builder of a DSS should know how to answer the questions it [DSS] will answer, and how to identify the questions it [DSS] cannot answer." (p. 113).

Earlier, Alter (1979) developed a methodology for the

implementation of DSS based on an identification of factors which could pose a risk to the successful implementation of a DSS, and an enumeration of implementation strategies to offset the impact of these implementation risk factors. This methodology offers a combination of a descriptive and a normative approach to the implementation of DSS. An examination of the implementation risk factors and strategies is a significant aspect of this research study.

## 2.5 Alter's Implementation Risk Analysis Methodology

Alter (1979) associates the concept of implementation risk factors with that of implementation risk analysis. He proposes an ideal implementation situation for DSS by imagining a case in which the implementation process could be planned and controlled with maximum certainty:

"The system is to be produced by a single implementor for a single user, who anticipates using the system for a very definite purpose which can be specified in advance with great precision. Including the person who will maintain it, all other parties affected by the system understand and accept in advance its impact on them. All parties have prior experience with this type of system, the system receives adequate support, and its technical design is feasible and cost effective." (p. 106)

Alter identifies as "implementation risk factors" the types of deviations which could reduce the certainty of the implementa-

tion process. His list includes:

- non existent or unwilling users.
- multiple users and implementors.
- disappearing users, implementors or maintainers.
- inability to specify purpose or usage pattern in advance.
- inability to predict and cushion impact on all parties.
- lack or loss of support.
- lack of prior experience with similar systems.
- technical problems and cost effectiveness issues.

Noting that the ideal situation rarely occurs, Alter suggests that comparisons with an ideal are useful for highlighting areas for corrective action. Using the checklist of risk factors, an implementation risk analysis can be performed a priori by proceeding as follows:

- (i) List every risk factor which seems to be applicable.
- (ii) For each risk factor, design a course of action to reduce the magnitude of the factor or its consequences.
- (iii) If it proves infeasible to achieve reductions in step (ii) to a tolerable level for each factor, abandon system implementation.

The primary benefit of this aspect of Alter's methodology is that it forces a "discipline for anticipating trouble or can

be formalized as part of the organization's procedures for selecting and authorizing projects." It can also be used as an adjunct to or a replacement for cost-benefit studies of DSS.

Alter identifies four basic approaches for dealing with these implementation risk factors:

- (i) divide the project into manageable pieces.
- (ii) keep the solution simple.
- (iii) develop a satisfactory support base.
- (iv) meet user needs and institutionalize the system.

He notes that the choice of specific strategies within each of these approaches will be based on a series of organizational considerations and situational limitations.

Alter's methodology is of particular interest to this study since it is primarily based on user experiences in development and implementation of DSS (as opposed to MIS or OR/MS) applications.

## 2.6 DSS Implementation Studies

A number of doctoral dissertations have been recently com-



pleted in the development and implementation of DSS. They exhibit an exploratory attitude toward the investigation of factors of success, perception, preference, etc. A general conclusion which emerges is that DSS implementation is a complex multi-dimensional phenomenon and requires a multi-disciplinary approach of investigative attack.

Fuerst (1979), in his field study of corporations (in the oil industry) who had already implemented DSS concludes that for increasing use of user-initiated reports, the apparently important factors are experience in the user's present position, user training, accuracy of output, and relevancy of output.

Kole (1979) investigates factors affecting decision makers' behaviour during DSS implementation with the help of advocates. An implementation team approach featuring user-oriented facilitators is recommended as a strategy to promote positive user attitude and behavioural change.

Welsch (1980) addresses two research questions:

- (i) What constitutes DSS implementation success and how is it to be measured?
- (ii) What factors relate to successful implementation of DSS?

With reference to the first question, a multi-dimensional measure focussing on DSS implementation success is found to be significant in terms of variables emphasizing (1) acceptance of DSS, (2) effective utilization of DSS and (3) user satisfaction with DSS.

With reference to the second question, factors found to be significantly correlated with perceived DSS implementation success include: (1) top management support, (2) user involvement in DSS development, (3) DSS impetus from the user group, (4) commitment of all parties, and (5) singleness of direction between users and designers. Welsch concludes that the benefits of participation outweigh the costs involved.

Duffy (1980) conducts an analysis of the contrast in attitudes towards computer-based long range planning and MIS among educators and businessmen. Based on a questionnaire analysis, he concludes that there is no difference in the attitudes of the two groups towards the systems examined, but that the age of the respondent and the number of years employed at his organization do form the basis for a significant difference in attitude.

Watkins (1980) conducts an exploratory study of top-level decision makers and their perception of and preference for various information items that might be supplied by a DSS.

Four homogenous groups emerge with similar "information" perceptions and preferences. These groups respectively emphasize mode of presentation dimensions, environmental dimensions, financial dimensions, and an aggregate of economic, competitive and financial dimensions.

Beverage (1981) develops a model which an analyst can use to determine the decision processes used by decision makers and to integrate the findings into a model of the organization. He reports successful use of his methodology for the development of a DSS in a manufacturing corporation.

It is interesting to note that all of these dissertations refer to an environment where the DSS developed involves users or managers who interact with system builders, either directly or through intermediaries. The phenomenon of manager-developed DSS appears indeed to be a recent one.

This concludes the presentation of the results of the literature survey, and leads to a statement of the research problem in the next chapter.

## CHAPTER III: THE RESEARCH PROBLEM

### 3.1 Introduction

The emergence of decision support systems (DSS) reflects a conscious effort to increase the involvement of the users and managers in the design, development and implementation of computer models and information systems. On the technical front, interactive computer systems with model-building and database management software have enabled the user to obtain quick responses to inquiries. On the behavioural front, project management techniques emphasizing the building of systems to fixed specifications are being slowly displaced by evolutionary and iterative processes for systems development.

This adaptive approach to DSS development has required frequent interaction between the system builder who is usually a technical analyst and the user who is generally a manager. While DSS implementation has been successful in a number of cases, it has often failed. According to the literature, these failures have often occurred due to an inability to

recognize and allow for the differences in perceptions, values and behavioral norms of the technical analyst and the manager. Since the use of a DSS by a manager is essentially voluntary in nature, a system may well prove to be a failure in a manager's view while at the same time meet high technical standards. One approach to eliminate (or at least minimize) the effects of this conflict in technical and managerial perspectives is for the manager to act as his own technical analyst. This combined role of the manager as a DSS builder and user is a focus of attention in this study.

There is as yet no agreed upon definition of a decision support system. Nevertheless, a basic characteristic of a DSS is that it supports the decision processes of managers with flexible access to models and relevant information. This study utilizes Alter's taxonomy for categorizing DSS in terms of the generic operations performed within each system.

### 3.2 A Taxonomy for DSS

The generic operations considered in Alter's taxonomy range from the extremely data oriented to the extremely model oriented. This leads to an identification of seven types of DSS. These are:

- (i) File Drawer Systems, providing access to data items.
- (ii) Data Analysis systems, for tabulation and selection of data etc.
- (iii) Analysis information systems, using models and databases.
- (iv) Accounting models, based on accounting definitions.
- (v) Representational models, for estimating consequences of actions.
- (vi) Optimization models, for optimal solutions subject to constraints.
- (vii) Suggestion models, for computerization of fairly structured tasks.

All the DSS examined by Alter fall into one of these categories, and none of the categories are empty. This study utilizes Alter's taxonomy to categorize the DSS developed by managers and identify any discernable patterns.

### 3.3 The Study Environment

The study involves users who are:

- practising (middle and senior) managers and professionals in the private and public sector.
- also the model developers, i.e. they develop models for use by themselves and their colleagues.
- conducting the process of design and development of DSS without the formal presence or participation of intermediaries or assistants.
- attempting to complete the process within a prespecified time limit.

Figure 1 is representative of the operational environment in which managers develop their DSS.

For this study, managers developing DSS normally use screen-based (CRT) computer terminals linked to a large mainframe computer via communication lines. Their models are written as "command" statements of the DSS software package, and data are generally appended to the models. No complex data management tasks (as with large data bases) are required of the managers in this problem solving environment.

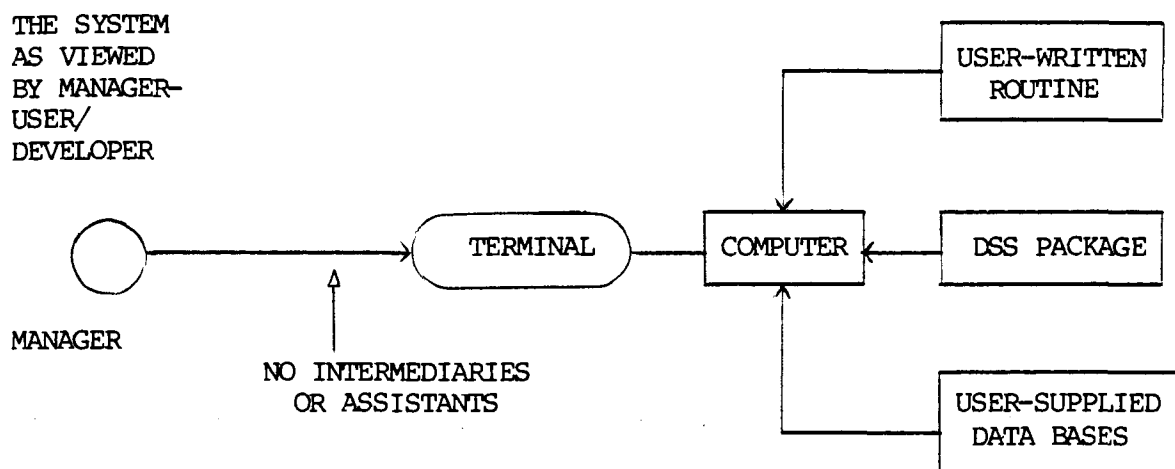


FIGURE 1: OPERATIONAL SCHEME OF DSS USAGE IN RESEARCH PROJECT



### 3.4 The Manager-as-Developer

The choice of the term "manager-as-developer" to describe the role of participants in this study is a purposeful one. The term "developer" as opposed to terms such as "builder", "user" or "implementor" used by other researchers recognizes the multiplicity of functions managers perform in the study environment. These range initially from problem finding (i.e., determining that the problem is worth investigating), to setting out the problem boundaries, leading to problem definition. This is followed by an explicit identification of the parameters of the problem for inclusion in a model. The model is next coded in the prescribed DSS language, and then tested and validated using data assembled from organizational sources. Finally, the project is documented to facilitate future usage.

The term "builder" does not completely describe the tasks undertaken by participants in DSS projects examined in this study. Some of the DSS projects are undertaken singly, and others in pairs. For the latter type, allocation of responsibilities does not necessarily require each individual team-member to perform model building. Data assembly or model testing and validation may be considered an equally acceptable sharing of tasks. The term "builder" also connotes previous experience, whereas for a number of study participants, their

DSS project may represent their first nontrivial effort.

The term "user" similarly describes just one aspect of participant roles. If two members of the same team are managers in different organizations (as is very likely), only one of them will ordinarily regard the problem being modelled to be organizationally relevant. The other team member will thus not be a "user" of the DSS model in the conventional meaning of the term. Yet, in testing and validating the model, he will be performing a combination of "builder" and "user" roles; in documenting the project from the user's point of view, he will be performing a task normally expected of a "user".

The term "implementor" is also considered and deemed inappropriate for general use since the DSS models are not always completed to a manager's initial specifications or total satisfaction. They are, however, a "prototype" or at some other evolutionary stage of implementation. For one-person projects, the overlap between the terms "developer", "builder", "user" and "implementor" is complete.

In his survey of DSS-related activity in the U.S.A., Wagner (1979) confirms the "manager-as-developer" activity by noting the participation of middle and senior managers in this role.

### 3.5 Implications of the Alter Methodology for this Research Study

Alter proposes that the examination of DSS implementation be done via an approach of implementation risk analysis based on the identification and management of risk factors. These risk factors are deviations between an "ideal" implementation situation and conditions under which a proposed implementation may take place. Alter identifies a number of types of deviations which can occur to reduce the certainty of the implementation process. These deviations he refers to as "implementation risk factors." For each characteristic factor in which a DSS deviates from the ideal, he suggests the design "of a course of corrective action which will either reduce the deviation itself or will control its consequences." (Alter 1980, p. 158).

This research study examines the implementation problems, approaches and strategies identified by Alter to determine if his groupings are valid in the manager-as-developer environment, and if the suggested linkages between implementation strategies and implementation problems continue to hold. Figure 2 depicts the way a manager is likely to experience an implementation problem and apply an offsetting implementation strategy. The use of the strategy may resolve the problem, in which case the development effort continues. Otherwise, the

manager can attempt to use another strategy. In the worst case, the use of one implementation strategy may create a new problem instead of solving the old one.

The typical hypothesis here is of the form that a linkage between a risk factor and an implementation strategy is likely to be present in the manager-as-developer environment. If a hypothesis is supported, it adds power to Alter's methodology as a general-purpose tool. If the hypothesis is rejected, it provides new information on DSS development in the manager-as-developer environment.

The evaluation of the implementation risk analysis aspect of Alter's methodology (undertaken prior to systems development) is beyond the scope of this study, since the DSS projects are examined after-the-fact, albeit very shortly after project completion. Thus the study does not determine if Alter's approach for successful DSS development by anticipating implementation roadblocks proves workable in this particular study environment.       •

Alter (1979) advocates that the problem of presentation of results involves "not only collapsing the data into summary measures and then drawing inferences, but also organizing and cataloging brief descriptions of many distinct situations." (p. 118) This advice is put to use in developing and

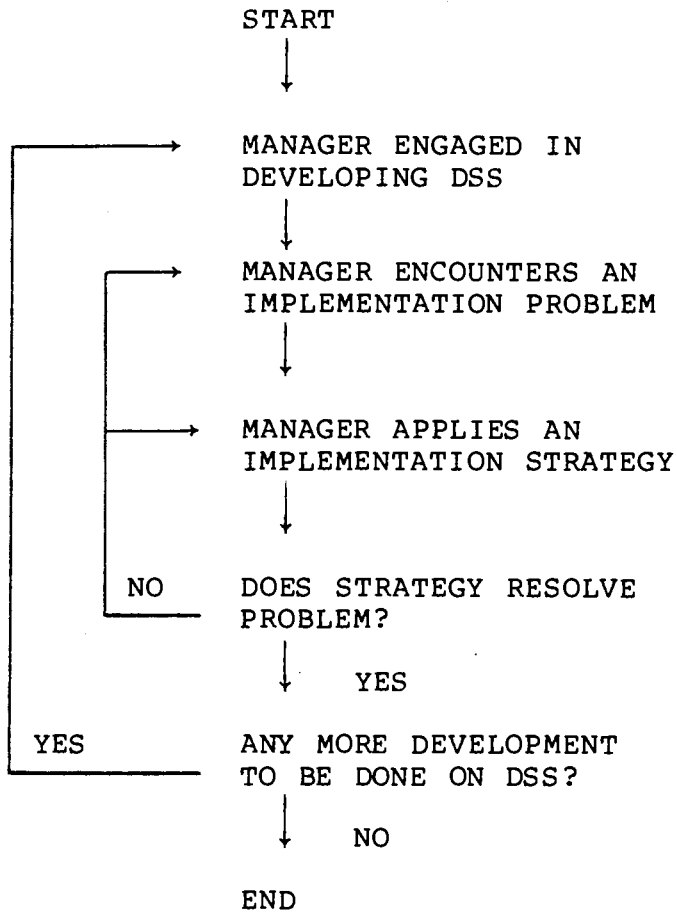


FIGURE 2: Relationship Between Implementation Problems and Implementation Strategies.

summarizing the findings of the research study.

### 3.5.1 Implementation Risk Factors and Related Problems

This research tests for the presence of the problems produced by the implementation risk factors identified in Alter's methodology.

These problems may not be present in all phases of system development, but they pose a risk to successful implementation of a DSS.

Problem 1: Non-existent or unwilling users.

The implication of this problem being present is that an individual is unwillingly undertaking a voluntary task of developing his own DSS.

Problem 2: Multiple users or implementors cause communication problems.

Absence of this problem implies that communication problems do not occur between team members, i.e., team communication problems do not affect project success to any degree through divisiveness of effort.

Problem 3: Multiple users or implementors lead to inability to incorporate multiplicity of interests.

The implication of this problem being present is similar to that for Problem 2 above; both problems can occur in tandem with the added element of multiplicity of purpose being introduced here.

Problem 4: Overoptimism among systems designers and users during some phase of development.

This problem refers to the management of expectations and its absence implies complete concordance between project specification and delivery.

Problem 5: Lack of motivation during some phase of development.

This problem pertains to the adaptive nature of DSS development, where a model evolves as a result of the learning process. Absence of this problem implies a positive motivation during the entire DSS development process.

Problem 6: Requests for funding denied, i.e. lack or loss of support.

This hypothesis pertains to the budgetary (e.g., computer time availability, dollars in funding or manpower allocation) resources available to a project. If this problem is present, it implies a dark prospect for the future of the project.

Problem 7: Lack of experience with DSS language, leading to mistakes.

This problem refers to the level of familiarity which participants have with the specific DSS language used. If this problem is absent, it implies an expert level of knowledge among project participants regarding the DSS language used, and may also reflect on the "user friendliness" of the language.

Problem 8: Technical problems with systems hardware.

This problem refers to the degree of computer system complexity faced by project teams, both with respect to messages originating from the system and with system responses to user input. It also refers to the complexities involved in operating a computer terminal to access the DSS language.

For all of the above problems, the common question being posed is whether they pose a risk to the development of a DSS by a manager.

The study examines a number of additional questions related to implementation problems. It tests for the significance of each implementation problem when analyzed by team size (of one or two managers). It determines the relative levels at which the implementation problems are present, in order to create a profile of the relative significance of these problems for manager-developed DSS. The investigation is expanded to test



for significance level of interactions between pairs of implementation problems.

### 3.5.2 Implementation Approaches and Strategies

The research study tests for the application of the implementation strategies identified by Alter in the manager-developed DSS environment. Alter's strategies fall within four general approaches:

Approach 1: divide the project into manageable pieces by the following strategies:

- use prototypes
- use an evolutionary or modular approach
- develop a series of tools.

The strategies under this general heading share the general objective of minimizing the risk associated with developing a large system which does not prove to be of any value to the user.

Approach 2: keep the solution simple by the following strategies:

- be simple in the modelling approach

- hide the complexity of the model
- avoid changes in the model.

The strategies fall under the heading "keep it simple" and represent a frequently observed prescription for implementation success in the literature. The typical choices under this approach are to solve those aspects of a problem which lend themselves to a simple solution or to disguise the complexity of the problem in the way the output is presented.

Approach 3: meet user needs and institutionalize the system by the following strategies:

- insist on mandatory use
- permit voluntary use
- provide on-going assistance
- rely on diffusion and exposure
- design systems to suit people's capabilities.

The only strategy considered appropriate for investigation in a manager-developed DSS environment is one of tailoring a DSS to the user's capability. Institutionalization of DSS is rejected from further consideration as being inappropriate, since solving problems is an integral part of the normal managerial function.

Approach 4: develop a satisfactory support base by the following strategies:

- obtain personal commitment from user
- obtain management support
- obtain user participation
- attempt to "sell" the system.

In the manager-developed DSS environment, where the manager is also a user, this group of strategies is perhaps not as critical as for cases where the manager is a user but not the developer. The strategy of obtaining management support is equivalent to that of obtaining user support in this environment, and is not therefore investigated separately.

It is possible that multiple approaches (and strategies) are used to resolve a single implementation problem, and that the same approach resolves multiple problems.

Alter asserts that the strategies for developing a satisfactory support base (Approach 4) by gaining user confidence, commitment and participation need to be applied in conjunction with each other. "Applying one without adequate attention to the others leads to ineffective implementation." (Alter 1980, p. 173)

This assertion is tested in the study, and the investigation is expanded to identify the significance level of interactions between implementation approaches, between implementation strategies, and in the linkages between implementation strategies and implementation problems.

### 3.6 Situational Variables for Managerial, Organizational and DSS Characteristics

A large number of variables have been examined in previous research studies to assess their impact on successful design and implementation of management information systems, OR/MS models and decision support systems. Some of these variables, based on an extensive literature survey, appear worth examining in the particular environment of this research study where the managers are also the DSS developers.

One particular attribute frequently encountered in DSS research is the cognitive style of managers. This is not included in this research study, and reflects the assessment of this topic by Schultz and Slevin (1979):

"... despite the promise of this research, few scientific generalizations or managerial implications have emerged from

these studies beyond the caveat that cognitive style should be taken as a model building constraint." (p. 9)

### 3.6.1 Situational Variables for Organizational Characteristics

The variables included in this category reflect the organizational environment in terms of its stability and exposure to competition and time pressures. Variables describing the type of workplace (head office or branch office), work function (staff or line), type of industry and level of organizational support for computer-based decision systems are also considered as part of this category.

### 3.6.2 Situational Variables for DSS Project Characteristics

The DSS variables relate to (1) the type of DSS developed (in terms of the Alter taxonomy described earlier in Section 3.2), (2) the type of decision modelled (routine or ad hoc), (3) the functional aspect of the organization represented (corporate or departmental), and (4) the time horizon considered.

### 3.7 Relationships between Implementation Problems, Strategies and Situational Variables

The study tests for the significance of relationships between the situational variables described above and implementation problems, between situational variables and implementation strategies, and between the situational variables themselves.

The relationships which are found to be statistically significant can be used in a prescriptive or diagnostic mode by managers or researchers.

As an extension of this investigation, the study assesses the evaluation by the DSS developers of a number of issues. These include identification of additional implementation problems (not previously reported by Alter), the value of their DSS development experience in terms of insight gained into the problem being modelled and their attitude towards potential DSS usage in the future, and an individual rating of the success of their projects.

### 3.8 The Usage and Acceptance of Computer-Based Systems (CBDS) in Organizations

Two points are worthy of note: (1) DSS are a new form of

CBDS, and (2) the phenomenon of manager-developed DSS is an even more recent one. It is therefore reasonable to question if this phenomenon is temporary in nature or if it is perceived to have lasting influence. Since DSS is a tool aimed at managers, the study examines the perception of managers as to the potential use of the general class of computer-based decision systems (and of DSS, as a subset) in organizations in terms of their usage and acceptance.

With respect to the gap between the present status of CBDS in organizations and as it "should be" (in a desired sense), the study investigates what issues appear to be significant in accounting for the perceived gap, and compares the perceptions of those managers who have developed DSS with those of another group of managers with no DSS development background.

The perceived gap issue is further analyzed by considering the degree to which a well-supported DSS facility bridges the gap between the present and desired states, and by identifying the significance of relationships between the situational variables (relating to managerial and organizational characteristics), and the issues or the perceived gaps. This information can be used in a diagnostic or a prescriptive mode for managers planning for efficient DSS use in their firms.

### 3.9 Key Research Variables

It is pertinent at this stage to summarize the variables which are analyzed in investigating the successful implementation of manager-developed decision support systems. They represent

1. The attitudes and perceptions of the responding managers towards computer-based decision systems in three scenarios: as these systems exist in respective manager organizations, as they should exist, and as they would if decision support systems were technically supported for use.
2. The implementation problems identified in Alter's methodology and implementation strategies used to overcome these problems.
3. Personal characteristics of managers, including levels of computer literacy.
4. The environmental characteristics of organizations, as well as levels of computer support.
5. Characteristics of the DSS development process.



### 3.10 Summary

This chapter presents the research problem examined in the study. It notes the evolution of manager-developed DSS as a recent phenomenon aimed at improving the likelihood of successful DSS development and implementation. It identifies the Alter taxonomy for DSS and the Alter implementation risk analysis methodology as a framework in which to examine the characteristics of manager-developed DSS. The study tests for significance of relationships between implementation problems, implementation strategies and a number of situational variables which encompass managerial, organizational and DSS characteristics.

It also examines the potential for usage and acceptance of computer-based decision systems (CBDS) in organizations by analyzing the nature of the gaps which exist between the present and desired states, and identifies the contribution of DSS as a specific CBDS in bridging the gaps perceived.

The next chapter outlines the methodology used for setting up the experiment, data collection and analysis.

## CHAPTER IV: METHODOLOGY

### 4.1 Introduction

This chapter contains a description of the data collection procedures and statistical tests used to test the research hypotheses and questions outlined in Chapter III. The data collection procedures are a combination of a multi-section structured questionnaire and personal interviews. The statistical tests are non-parametric in type; these tests require fewer qualifications as to the nature of the data than do their parametric counterparts.

Discussion of hypotheses and statistical tests is organized in the same sequence as the results presented in Chapters V and VI.

### 4.2 Data Collection Procedures

The intended respondents are practising managers and professionals who have previous exposure to quantitative decision-

making through a graduate level course in Operations Research. A subset of these have hands-on experience in developing decision support systems. This latter subset is known to be small in size, owing to the relative novelty of managers as developers of DSS rather than the more common situation of managers as users of DSS. These managers and professionals are enrolled in the Executive MBA program at Simon Fraser University. Among those entering the third year in the fall of 1982 are some who elected to take the MIS/DSS course in the previous spring. As part of this course, they get hands-on experience in developing a DSS model; those who work in pairs usually choose to develop a model with some relevance to one of the organizations represented in the team. The rest are individual efforts at DSS development. The projects represent problems of personal as well as organizational significance. In addition to completing questionnaires, members of this group are also interviewed on various aspects of their DSS development.

Members of the second and third year MBA classes who have not taken the MIS/DSS course also participate in this study. They complete the questionnaires on (1) the use of computer-based decision systems in their organizations, (2) their personal data on academic and managerial background, and (3) their attitudes towards computer-based decision systems.

#### 4.2.1 Sample Size & Quality of Response

The total available sample size for the experiment is the enrolment in the two classes, totalling eighty-four (84); the group without DSS experience accounts for a total of fifty-three (53); the group of DSS developers totals thirty-one (31).

By conventional research study standards, these may be considered small samples. However, owing to the relative novelty of the managerial activity being investigated, the costs and time involved in obtaining and interviewing a larger sample could prove to be prohibitive. Also, the qualifications of the respondents who participate in this study are considered to be uniformly higher than what may be normally expected, given their prior coursework in the MBA program.

Of the fifty-three managers without DSS experience, forty-one participate in this study. Twenty-nine of the thirty-one DSS developers answer questionnaires and are interviewed. The extremely high response rates of seventy-seven percent from these samples generates the same number of respondents as in drawing a smaller response rate from a larger sample.

Response rates of 15 to 20 percent are normal for studies of this type. As well, the approach taken in this study permits frequent access to the respondent managers. This enables

gathering of evaluative and anecdotal data which adds significantly to the present level of knowledge.

#### 4.2.2 Pre-Testing the Questionnaires

Each section of the questionnaire is pre-tested twice over a small number of managers, including some from industry at large. The pretest helps to clarify the meanings, the sequence of questions, the time required for completion, as well as the procedures for pick-up and delivery. A review of notes from the first few interviews leads to the development of a structured questionnaire which considerably shortens the length of the interviews while still capturing the desired information.

#### 4.2.3 Questionnaire Administration

Johnson (1974) notes that the achievement of successful entree to the respondent group is a precondition for doing the research: "no entree, no research". The high response rate is stimulated by several factors. Firstly, questionnaires are handed out to a number of respondents who have assembled for a week-end. These questionnaires are either completed during the week-end or very shortly thereafter. A favourable

response from these respondents later influences the completion of questionnaires by those who are not present at the week-end get-together. All respondents are guaranteed confidentiality (not anonymity) through the use of pre-assigned code numbers on questionnaires. Informal communication from the supervisory committee of this research study also encourages the subjects to participate in the data gathering process. Access to the group is also facilitated by prior acquaintance with one of its members.

The group of managers with no DSS experience completes two questionnaires (see Appendix 1, Questionnaire Sections 1 and 2); the DSS developers complete three questionnaires (see Appendix 1, Questionnaire Sections 1, 3 and 4) and also participate in a personal interview (see Appendix 1, Questionnaire Sections 5 and 6 for information collected). The returned questionnaires are verified for responses to all questions. Coded responses are checked against the responses to open-ended questions for consistency. For the group of DSS developer-managers, the final interviews offer an opportunity to clarify ambiguous responses to open-ended questions. The researcher then converts the data from the completed questionnaires to the coding format required by the computer program used for data analysis.

After keypunching of the data corresponding to the responses, each questionnaire is matched against the coded data for consistency. This step is feasible only due to the modest size of the sample.

The data collection phase of the study is carried out during September - October 1982. For the managers who develop DSS, this activity follows their project completion within five months.

### 4.3 Questionnaire Information Content

The questionnaires are grouped into five sections. Sections 1 and 2 are completed by the group of managers who have not developed the DSS examined in this study. Sections 1, 3, 4 and 6 are completed by the other group. A brief review of each section of the questionnaire follows below.

#### 4.3.1 Questionnaire Section 1

Section 1 is organized to collect data on the respondent's academic and managerial background, his exposure to computer-

based decision systems, and characteristics of his organizational environment.

#### 4.3.2 Questionnaire Section 2

Section 2 is organized to collect the opinions of the respondents who have no DSS developmental background, on the present status of computer-based decision systems in their organizations. They are also asked to identify what it "should be" in a desired sense. Each aspect of the inquiry is posed as a statement, to which responses can vary from STRONGLY AGREE to STRONGLY DISAGREE on a five-point Likert scale. Following each such inquiry is an open-ended question which probes the respondent's thinking on key aspects of the previous statement of inquiry.

#### 4.3.3 Questionnaire Section 3

Section 3 contains the same opinion-seeking statements as in Section 2, except that now each aspect of the inquiry includes a third query. The first refers to IS, requesting an opinion on the applicability of the statement to the present state of the organization. The second refers to SHOULD BE, pertaining to the respondent's desired (or idealized) state for that



statement. The third query is IF DSS USED; this requests the respondent's opinion on the applicability of the statement to the situation if a decision support system is available and adequately supported for use within the organization. As an illustration, the following is extracted from Section 3 of the Questionnaire to indicate a sequence of possible responses (together with an explanation) for one specific inquiry statement.

AN EXAMPLE: A sample statement might read as follows:

THE PLANNING PROCESS IS INDISPENSABLE IN MY ORGANIZATION.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	<u>D</u>	SD
SHOULD BE	<u>SA</u>	A	N	D	SD
IF DSS USED	SA	A	<u>N</u>	D	SD

The first line of the answer (for IS) indicates the respondent's perception that the planning process is not really indispensable in his organization.

The second line of the answer (for SHOULD BE) reflects the respondent's strong perception that the planning process should be indispensable in his organization.

The third line of the answer (for IF DSS USED) indicates that in the respondent's perception, the availability of a DSS in his organization would not materially change the present situation regarding the role of the planning process in his organization. It would also not be a useful aid in achieving the SHOULD BE status, i.e., a DSS is not the 'answer' in this situation.

This statement of inquiry also appears in Section 2 of the questionnaire, with one difference; the third query, i.e., IF DSS USED, is not present.

#### 4.3.4 Questionnaire Section 4

Section 4 of the questionnaire is organized to determine the extent to which problems produced by the implementation risk factors identified in Alter's methodology impact DSS project development.

As such, Section 4 is of interest and administered only to the group of DSS developer-managers. The essence of this section

is captured here by reproducing (from Appendix 1, Questionnaire Section 4) the instructions given to the respondents, and a representative response to one problem statement.

INSTRUCTIONS TO RESPONDENTS:

This section of the questionnaire refers specifically to the DSS project you undertook as an assignment in your MIS course last spring.

Listed below are a number of problems which have been reported in DSS developments elsewhere. Please indicate your assessment of each factor as it affected your own project. If a factor in any way influenced the development of your DSS, please indicate in the space provided below the question:

- WHEN DID THE PROBLEM ARISE?
- HOW WAS IT RECOGNIZED?
- WHAT STEPS YOU TOOK TO OVERCOME THE PROBLEM?
- WITH WHAT SUCCESS?
- DID IT CREATE ANY NEW PROBLEMS?

Note that more than one problem can easily occur during the development of a DSS.

AN EXAMPLE: A sample problem might be:

OVEROPTIMISM AMONG DEVELOPERS IN SYSTEM DESIGN.

Check one (to indicate severity):

Extreme \_\_\_\_\_; Great  X ; Some \_\_\_\_\_;

Little \_\_\_\_\_; Not at all \_\_\_\_\_.

Comments regarding Problem/Resolution/After Effects:

The problem impacted DSS development efforts to a great degree, mainly because the entire team was caught in their overoptimism. The problem was recognized just two weeks from the deadline for the project completion. It was caused because we had not been specific enough about the output we wanted, and how we would use the results. We resolved the problem by down scaling our design specifications, and were able to meet the deadline. It also meant many long and mistake-ridden sessions on the computer terminal. We ended with a sense of disappointment that the rewards were not commensurate with our efforts. Next time, we'll know better.

#### 4.3.5 Questionnaire Sections 5 and 6

Section 5 of the questionnaire lists a number of exploratory questions to ask of each of the DSS project teams. The members of a team are usually interviewed at the same time. After a few such interviews, a review of the discussion notes indicates that the process can be considerably shortened by developing yet another structured questionnaire to capture data on the applicability of the various strategies suggested by Alter's methodology to DSS development in the study environment. This questionnaire is administered during the interview itself, and facilitates a focussed discussion of strategies used by the project teams. It is shown in Appendix 1, Section 6.

#### 4.3.6 DSS Project Writeups

Project team reports on their DSS models are made available to the researcher as additional background information. Shortly after each interview a brief report of the discussion is written by the researcher, in order to capture details of the chronological development of the project as well as to record anecdotal data on problems encountered and strategies used by the developers. These DSS project writeups are assembled in Appendix 3. Extracts from these project reports are included

in Chapter 6 to complement the discussion of the statistical results.

#### 4.4 Statistical Treatment of Research Questions

The study makes no assumptions about the nature of the population from which the sample of managers is drawn. This requires the use of non-parametric statistical techniques for analysis of data. The conclusions derived from the use of these techniques require fewer qualifications than is the case with parametric tests.

Four types of tests are used for statistical analysis in this study. The one-sample chi-square test is used to determine if a single sample is drawn from a specified sort of population. The Wilcoxon matched-pairs signed ranks test is used to compare the responses yielded by two related samples, such as one respondent's answers to two related questions. The Kruskal-Wallis one-way analysis of variance by ranks test is used for deciding whether the differences among responses to a variable signify genuine population differences when analyzed by discrete levels of another variable. The fourth type of test is a cross-tabulation of the joint frequency of two or more variables. A significance level of .05 is used as a cut-off for all these tests. In addition to these tests, one-way

frequency distribution statistics are also computed for a number of variables.

The SPSS (Statistical Programs for the Social Sciences) computer package is used to perform all of the above-mentioned statistical analyses.

The discussions of the hypotheses, statistical models and tests follow in the next two sections, (4.5 and 4.6) and correspond to Chapters V and VI on study results.

#### 4.5 Discussion of Methodology Used for Investigating Organizational Usage and Acceptance of Computer-Based Decision Systems

Analysis of issues related to the usage and acceptance of computer-based decision systems are reported in Chapter V. The analysis is based on data from Questionnaire sections 1, 2 and 3.

##### 4.5.1 Current and Potential Status of CBDS in Organizations

Respondents to the questionnaire survey are asked to evaluate ten statements relating to the use and acceptance of computer-

based decision-making systems (CBDS) in their organizations. These statements are referred to in this chapter and the following as Statements, and are shown in Table 1. The term "organization" includes all personnel who ultimately report to a respondent's immediate superior, i.e. the respondent, his subordinates, his peers (with the same superior) and their subordinates. All respondents are asked to respond to each Statement as follows:

First, how important IS the statement as it applies to your organization at present? This is referred to later as the "AS IS Query". Second, in your judgment, how important SHOULD the statement BE in your organization? This is referred to later as the "SHOULD BE" Query.

In addition, respondents who have developed any of the twenty-one DSS examined in this study are asked to take note of this experience, and asked:

Having used a Decision Support System ..., how important would the statement be if a DSS were available and supported technically for USE in your organization? This is referred to later as the "IF DSS USED" Query.

Respondents rate each Statement for each of the related Queries on a 5-point Likert scale ranging from "Strongly Agree" to



Statement Number	Statement
1	The decision making process in my organization allows for inclusion of judgmental input from managers.
2	In my organization, management gives support to the use of computer-based decision systems for decision making purposes.
3	The decision making procedures used in my organization clearly include the impact of uncontrollable external factors such as economic or social trends.
4	Managers in my organization delegate the quantitative analysis aspects of their decision making functions to a technical person such as an analyst.
5	In my organization, outside consultants are hired for use of computer-based decision systems.
6	In my organization, computer-based decision systems have been used in the last twelve months in support of our decision making activities.
7	In my organization, managers know how to make effective use of computer-based decision systems.
8	In my organization, the goals of a computer-based decision system are defined explicitly in terms of the decisions it will assist.
9	Technical aspects of computer-based decision systems have retarded the development of timely decision making information in my organization.
10	In my work, I personally make use of computer-based decision systems.

Table 1: Statements Related to CBDS Use and Acceptance in Organizations.

"Strongly Disagree". They may, in addition, comment in writing on their choice of answers for any Statement.

#### 4.5.2 Null Hypotheses, Statistical Models and Tests for Statements Indicating Organizational Use and Acceptance of Computer-Based Decision Systems (CBDS)

##### 4.5.2.1 Introduction

In this section, items of interest common to all ten Statements are discussed. Firstly, null hypotheses and statistical models are set out for each Statement for each Query type. Secondly, the term "perceived gap" is introduced to describe a measure of the level of dissatisfaction with CBDS usage and acceptance. Gaps are measured as the differences in responses between each pairing of the AS IS, SHOULD BE and IF DSS USED type of Queries for each statement. Thirdly, managerial and organizational characteristics considered in this study as impacting the successful development of DSS are described and their characteristics noted. Fourthly, overall indices are formulated for each type of Query across all ten Statements. Finally, the relationships of Perceived Gaps with situational variables are tested for statistical significance.

In each instance discussed in this section, the appropriate null hypotheses and statistical models are formulated. Figure 3 summarizes the various tests used.

#### 4.5.2.2 Statistical Analysis of Statements by Type of Query

A general null hypothesis is formulated that for each Statement for each type of Query the median response would be "neutral", i.e. at the 3.0 level. The expected distribution is for 35 of the 70 responses to be at or below the 3.0 level, and the rest above the hypothesized median. The statistical model for this hypothesis consists of a one-sample chi-square test, i.e. a goodness-of-fit test. The test is whether a significant difference exists between the observed number of cases in each category and the expected number specified. The significance level of 0.05 is used as the cut-off point for this test.

#### 4.5.2.3 Overall Indices for DSS Usage and Acceptance

The average respondent score of the responses for AS IS type of Queries to the ten Statements is formulated as his AS IS Overall Index. Indices are similarly formulated for the

Type of Analysis	One-Sample Chi-Square Test	Wilcoxon Matched Pairs Ranked Sign Test	Kruskal- Wallis One-Way ANOVA by Ranks Test and Chi- Square Test
1. Analysis of Statements by by type of Query (a) AS IS (b) SHOULD BE (c) IF DSS USED	X X X		
2. Overall Index for Statement	X		
3. Analysis of Perceived Gap (a) AS IS <u>vs.</u> SHOULD BE (b) AS IS <u>vs.</u> IF DSS USED (c) IF DSS USED <u>vs.</u> SHOULD BE		X X X	
4. Analysis of AS IS Statements by Situational Variables			X
5. Analysis of Perceived Gaps by Situational Variables (a) AS IS <u>vs.</u> SHOULD BE (b) AS IS <u>vs.</u> IF DSS USED			X X

Figure 3: Summary of Statistical Tests for Organizational Use and Acceptance of Computer-Based Decision Systems (CBDS).

SHOULD BE and IFF DSS USED type of Queries. Null hypotheses for each type of Query for each Statement, and for each Overall Index are formulated to reflect a median response of "neutral", i.e. a level of 3.0 in each case.

The statistical model and test for this null hypothesis is the same as for the Statements by Type of Query in Section 4.5.2.2.

#### 4.5.2.4 Perceived Gap in DSS Usage and Acceptance

It is hypothesized that respondents would perceive a gap between the AS IS vs. SHOULD BE, AS IS vs. IF DSS USED and IF DSS USED vs. SHOULD BE types of Queries; "perceived gap" is defined in each case as a measure of their level of dissatisfaction with or a desire for change in CBDS usage and acceptance. The operational null hypothesis is that there is no difference in the responses to the AS IS, SHOULD BE and IF DSS USED Queries over all Statements. If there is any difference in the responses to any pair of Queries, in order for the null hypotheses to be true, the differences must be randomly distributed with a mean difference of zero.

The statistical model for this hypothesis is a related two-sample case with random variation. The Wilcoxon matched-pairs ranked-sign test (Hull and Nie, 1979, pp. 53-54 and Siegal, 1956, pp. 75-83) is chosen as the appropriate non-parametric test. Observations from one Query type (for example, AS IS) are paired with observations for the same Statement for a second Query type (for example, SHOULD BE). Their differences in scores are noted in terms of sign and magnitude. These differences are then ranked in terms of their absolute values, i.e. without consideration of the signs. The sums of the ranks for the positive and negative differences are calculated. From these rank sums, a test-statistic Z is derived. For each null hypothesis, the Z-score will be normally distributed with a mean of zero and a variance of one. A significance level of 0.05 is chosen as the cut off point for this test.

#### 4.5.2.5 Situational Variables for Managerial and Organizational Characteristics: Null Hypotheses and Statistical Models

The literature survey suggests that a number of situational variables affect the successful development of computer-based decision systems. Nineteen such variables have been selected for this study, and are stated in Table 2.

Seq. No.	SPSS Var. Name	Managerial and Organizational Characteristics
1	XPDSSA	Knowledge of computer-based decision systems prior to enrolment in MBA program.
2	XPDSSB	Present knowledge of computer-based decision systems.
3	XPDSSORG	Level of organizational support in use of computer-based decision systems.
4	DSSVIEW	Overall attitude towards computer-based decision systems.
5	MGTLVORG	Management level in organization.
6	YRSINJOB	No. of years in present position.
7	YRSINCO	No. of years in present firm.
8	YRSINDM	No. of years of managerial decision-making experience.
9	AGEGRP	Age Group.
10	SEX	Sex
11	EDULVL	Highest educational level attained.
12	EDUFLD	Field in which highest educational level attained.
13	STBLORG	Stability level of org. environment.
14	CMPINORG	Level of competition with other organizations.
15	TIMPRORG	Level of time pressures encountered in organization.
16	TYPORGST	Organization Status: Head Office, etc.
17	TYPORGFN	Organization Function: Staff or Line.
18	TYPIND	Type of Industry in which organization exists.
19	YRCODE	Identification of respondents with DSS development experience.

Table 2: Managerial and Organizational Characteristic Variables Examined in Study.

#### 4.5.2.6 Relationship Between AS IS Type Statements and Situational Variables

A general null hypothesis can be formulated that, except for random variations, the median responses to each of the AS IS Statements will be at the same levels for each sub-group when the respondents are grouped by situational characteristics stated in Table 2. The statistical model is one of K independent samples, i.e. with K sub-groups classified along a dimension of managerial and organizational characteristics. Under the null hypothesis, a test of these sub-groups against a dependent variable (i.e. the AS IS type of Query applied to any of the Statements) will only show random variations.

The Kruskal-Wallis one-way analysis of variance by ranks (Hull and Nie, 1979, pp. 62-63 and Siegal, 1956, pp. 184-192) is chosen as an appropriate non-parametric test of this general hypothesis. In this test, all responses from the K sub-groups are ranked in a single distribution, and the sum of the ranks calculated for each sub-group. From these, the Kruskal-Wallis H statistic is calculated. If the K sub-groups are actually from the same population, i.e. that the null hypothesis is true, then the Kruskal-Wallis H statistic has approximately a chi-square distribution with K-1 degrees of freedom. A significance level of 0.05 is chosen as the cut-off point for this test. If the significance level exceeds 0.05, it will be



concluded that any differences among the K sub-groups are due to random variations.

#### 4.5.2.7 Relationship between Perceived Gaps and Situational Variables

A null hypothesis is formulated that scores for Perceived Gaps between AS IS vs. SHOULD BE and AS IS vs. IF DSS USED pairings of Queries would be at the same levels (except for random variations), when the respondents are grouped by situational variables for managerial and organizational characteristics. The statistical models and non-parametric tests are those stated in Section 4.5.2.6 for testing the relationships between the Statements and situational variables. The statistical model is one of K independent samples, the test is the Kruskal-Wallis one way analysis of variance by ranks, and the cut-off is at the significance level of 0.05.

#### 4.5.2.8 Use of Descriptive Information

Where applicable, comments made by respondents are used to support or explain the results derived from statistical tests and other analysis.

#### 4.6 Discussion of Methodology for Manager-Developed DSS

Analysis pertaining to the twenty-one DSS projects examined in this study, and information from Questionnaire sections 4, 5 and 6 which relate to these projects is presented in Chapter VI. The presentation of results uses a combination of statistical and descriptive information. Statistical analysis is performed using the SPSS computer program package.

In Chapter VI, hypothesis testing is performed for implementation problems, implementation strategies, and situational variables encompassing managerial, organizational and DSS project characteristics. These hypotheses and associated statistical models and tests are described below. Figure 4 illustrates the correspondence between the analyses and the statistical tests.

##### 4.6.1 Hypothesis Testing of Alter's Implementation Risk Factor-Related Problems

After completion of their DSS projects, manager-developers are asked to complete Questionnaire Section 4 and 6 pertaining to their experiences during the process of developing the DSS. Data from the questionnaires are used in testing hypotheses

Type of Analysis or Statistical Test of Significance	One-Sample Chi-Square Test	Wilcoxon Matched Pairs Signed Rank Test	Kruskal-Wallis ANOVA Test and Chi-Square Test
1. Implementation Problems	X		
2. Implementation Problems by Team Size			X
3. Relationship between Implementation Problems			X
4. Implementation Problems vs. Overall Implementation Problem Index		X	
5. Implementation Strategies	X		
6. Implementation Strategies by Team Size			X
7. Implementation Problems vs. Implementation Strategies			X
8. Relationship between Implementation Strategies			X
9. Situational Variables	X		
10. Implementation Strategies vs. Situational Variables			X
11. Implementation Problems vs. Situational Variables			X
12. Relationship between Situational Variables			X

Figure 4: Summary of Statistical Tests for Manager-Developed DSS and Alter Methodology.

for problems related to the DSS developments considered in the study.

A general research hypothesis is formulated that problems due to implementation risk factors (identified by Alter) have an equal likelihood of being present or absent. The phenomenon of manager-developed DSS is still so uncommon that a more specific hypothesis cannot be formulated at present. For each implementation problem, an associated hypothesis is formulated that there will be a significant difference in the extent that an implementation factor-related problem impacts DSS development when analyzed by project team size (1-person or 2-person teams are possible). An overall implementation problem (OIP) index is formulated for each respondent as the average of his responses for implementation problems.

The statistical model for the null hypothesis corresponding to any of the general research hypotheses is a one-variable chi-square test. The hypothesized mean for this test is at the 1.0 level score of response, i.e. that the responses for the factor-related problem is "not at all" present would equal in number all of the responses for the various levels at which a factor-related problem is present. The significance level for the test is set at .05.

The statistical model for the null hypothesis corresponding to any of the associated research hypotheses for team size is one of K-independent samples. The Kruskal-Wallis one-way analysis of variance by ranks test is used to measure the significance of differences in scores for factor-related problems when analyzed by the K levels of team size. A significance level of .05 is used for this test.

#### 4.6.2 Relationship Between Implementation Problems

The Kruskal-Wallis ANOVA test is used to investigate the statistical significance of differences in scores for one implementation problem when analyzed by the levels of another implementation problem. A cut-off of .05 is used as a level of significance.

An associated hypothesis is formulated that there is no difference in a manager-developer's score for any individual implementation problem and his overall implementation problem (OIP) index. The statistical model for this hypothesis is a matched pair of samples, the OIP index scores being matched against the scores for the individual implementation problems. The Wilcoxon matched-pairs signed rank test is chosen as the most appropriate non-parametric test; a significance level of .05 is used as the cut-off for this test.

#### 4.6.3 General Hypothesis and Statistical Model for DSS Implementation Strategies

The exploratory research hypothesis is that each of the implementation strategies is as likely as not to have been used by manager-developers. For this relatively new phenomenon of manager developed DSS, a stronger hypothesis cannot be prudently offered. The null hypothesis is that usage and non-usage of a strategy are equally likely. The statistical model for this general null hypothesis is a one-sample chi-square test. The hypothesized mean is at the 1.0 level, i.e. the number of responses in the "not at all" category would equal those for all the other categories taken together.

#### 4.6.4 Relationship between Implementation Problems and Implementation Strategies

The statistical significance of differences in scores for implementation strategy usage is analyzed by (i) levels of scores for implementation problems, and (ii) levels of use of another implementation strategy. The Kruskal-Wallis ANOVA procedure is used for these analyses; a significance level of .05 is used as a cut-off for these tests.

#### 4.6.5 Statistical Significance Tests for Situation Variables

In order to explore the nature of DSS development by managers-as-builders-and-users, managers are asked to rate the extent to which certain situational variables are present in their DSS projects. The research hypothesis is that these variables are equally likely to be present as to be absent. The corresponding null hypothesis states that there will be an equal distribution of the two types of responses. The statistical model is a one-sample chi-square test, with a significance level of 0.05.

#### 4.6.6 Relationship Between Implementation Strategies, Implementation Problems and Situational Variables

The Kruskal-Wallis ANOVA procedure is used to test for the significance of differences in scores for:

- (i) implementation strategies among different levels of situational variables.
- (ii) implementation problems when analyzed by different levels of situational variables.
- (iii) one situational variable when analyzed by different levels of another situational variable.

#### 4.6.7 Use of Descriptive Information

Use is made of information collected during interviews, from questionnaires and project writeups (see Appendix 3) to support or explain the results derived from statistical analysis.

#### 4.7 Summary

This chapter outlines the methodology followed in the study for data collection and analysis. The data collection is through the use of structured questionnaires and interviews, and the analysis uses nonparametric statistics. The results of the study are presented in Chapter V and VI.



CHAPTER V: DISCUSSION OF RESULTS: USAGE AND  
ACCEPTANCE IN ORGANIZATIONS OF  
COMPUTER-BASED DECISION SYSTEMS (CBDS)

5.1 Introduction

In this chapter, results from analyses of questionnaire-based information from Questionnaire sections 1, 2 and 3 (samples of all questionnaires are included in Appendix 1) are presented in the form of statistical and descriptive evidence. Analyses pertaining to the twenty-one DSS projects examined in this study, and information from Questionnaires 4, 5 and 6 which relate to these DSS projects are presented in the next chapter.

5.2 Demographic Characteristics of Sample

The descriptive statistics of the demographic variables are summarized here. Of the 70 respondents, 11 are in the top management category, 36 in middle management, 7 in supervisory management, 14 in the category of professionals (such as

accountants, engineers, etc.), and 2 in the "other" classification. Respondents in this last group perform "staff" management functions in a co-ordinating capacity, and for analytical purposes are combined with "professionals". Fifty-three of the respondents are males, seventeen are females. The age distribution is skewed towards the 30-40 age group, with 39 of the 70 in the 30-35 range and 17 in the 36-40 category. As to educational level, 55 of the 70 have a bachelor's degree or an accredited professional diploma, and another 10 have master's degrees. The fields of education represented in the sample include 25 from engineering and technology, 16 from business administration, 11 from the Arts and 9 from the Sciences. The rest are drawn from the social sciences such as Education, Social Work and Public Administration. The extent of managerial decision making experience ranges from 2 to 25 years, with a median of 9 years. The median for experience in the same job position is 2.15 years, and for experience in the same firm it is 4.64 years. Forty-three of the seventy respondents are employed in a staff management function (including professionals) and 24 in a line management function. On account of the nature of this study, the three respondents employed in provision of computer services to their organization are grouped separately.

As to place of employment, 36 of the 70 are employed in a head office facility, 29 in a branch office; 5 self-employed

respondents operate from facilities too small to group with the other categories, and are grouped as "other". Of the industries represented in the sample, the categories with the largest representation are 12 respondents in consulting services, 10 in manufacturing, 9 in educational institutions, 8 in utilities (communications, power and transportation), and 7 in distribution. Various levels of government, (provincial and local) and government supported organizations (crown corporations, public institutions, social services, etc.) together with financial and land development organizations make up the rest of the sample.

The demographics of the sample therefore reflects a broad cross-section of the top and middle management in the private and the public sector which are important to the economy of the province of British Columbia.

### 5.3 Descriptive Analysis of "Statements"

Each Statement is included in the research study as representing an important aspect of the usage and acceptance of computer-based decision systems (CBDS) in general, and decision support systems (DSS) in particular. The term CBDS includes MIS, OR/MS and DSS applications used for managerial decision making.

5.3.1 STATEMENT 1

THE DECISION MAKING PROCESS IN MY ORGANIZATION ALLOWS FOR INCLUSION OF JUDGMENTAL INPUT FROM MANAGERS.

Comments from respondents are expected to indicate the various ways judgmental input is used in the decision making process. The physical setting is identified mainly as informal and formal meetings. Respondents to the AS IS Query, while agreeing with the inclusion of their judgmental input in the organizational decision making process, comment on the frequently arbitrary nature of the process, the possible replacement of judgment by whim, and the substitution of autocracy for consultation. Time constraints are identified as a primary reason for soliciting judgmental (and analytical) input, but a distinct lack of feedback is noted by middle managers; e.g., "Managers prepare initial budget submissions but are seldom consulted on changes made by top management."

Respondents comment more positively on the SHOULD BE and IF DSS USED categories, although some consider the increased use of judgment to have an effect similar to speculation. The availability of quantifiable information to support managerial judgment and experience is duly noted; however, a concern is expressed that the availability and use of a DSS would not necessarily change the way managerial input is used, e.g. that

an autocratic approach would prevail in situations where the DSS based information is not in agreement with top management views. Finally, one respondent who is relatively new to her organization, offers this assessment: "My superiors and colleagues (1) believe in magic (2) believe that good things come to good people (3) trust in serendipity or fortuitous events, and furthermore believe (4) that they will know "it" when they see it (5) that their experience will light dark pathways (6) that planning is a communist plot (7) that facts cloud instinct."

### 5.3.2 STATEMENT 2

IN MY ORGANIZATION, MANAGEMENT GIVES SUPPORT TO THE USE OF COMPUTER-BASED DECISION SYSTEMS FOR DECISION MAKING PURPOSES.

Top management support has been identified in the literature survey as an important factor in explaining successful development and implementation of CBDS. Comments on this Statement are expected to point out various ways in which management support or resistance is expressed. A typical positive response is that "computer-based information is submitted as a partial justification of say, financial decisions, and middle managers are encouraged to get hands-on use of the computer system." Neutral and negative responses reflect on

the unsuccessful results of previous management participation and support, e.g. "some systems we have are poorly designed -- unsure whether this is because managers involved with the design team did not understand what the goals were or if the specialists overwhelmed the users during the design stage."

Lack of management support is noted in a variety of forms: lack of funding or a low priority for CBDS applications, emphasis on cost recovery for computer applications, a management philosophy of "why change" and obstruction from the EDP department in placing computer tools in the hands of the user.

Responses to the SHOULD BE and IF DSS USED categories are similar in thrust. While recognizing that better judgment might be possible from CBDS or DSS-based information, a number of factors are identified as essential to the successful integration of CBDS and DSS with decision making. These include standardized formats for comparison of decision alternatives, adequate management training in CBDS, and the allocation of sufficient resources in manpower, capital and time to accomplish the required development. One respondent has serious doubts about top management acceptance of DSS: "for the bulk of our directors, their idea of a DSS is a pencil."

5.3.3 STATEMENT 3

THE DECISION MAKING PROCEDURES USED IN MY ORGANIZATION CLEARLY INCLUDE THE IMPACT OF UNCONTROLLABLE EXTERNAL FACTORS SUCH AS ECONOMIC OR SOCIAL TRENDS.

This Statement is included to determine the extent to which organizations recognize the impact of uncontrollable factors on their decision making, and to establish the strength of the relationship between this recognition and its inclusion in CBDS or DSS specifications.

For the AS IS Query, a popular response in agreement with the Statement is that uncontrollable factors are included by some combination of intuition and judgment. For example, "contingencies are discussed fully, plans are developed with built-in flexibility." Another point made is that these factors are usually considered at the top management level as policy decision parameters. Neutral responses indicate that consideration of other uncontrollable factors such as in the political arena are considerably more complex than of social or economic factors, e.g., "at present we are unable to respond to external factors because the government cannot clarify our funding levels. Therefore managers are unable to plan and carry out those plans." Then, as a negative response, there is the better mousetrap philosophy: "There is resistance to

expenditures for what is perceived as wasteful research and a belief that the right mousetrap will change the world."

For the SHOULD BE Query, positive responses recognize the incorporation of these factors in strategic planning activities via sensitivity analysis and contingency planning. Neutral and negative responses reflect a lack of knowledge as to the process by which this information is utilized in the organization.

For the IF DSS USED category, positive responses recognize the value of a DSS in evaluating possible impacts of these factors to reduce the degree of risk in decision making. Neutral and negative responses interpret the Statement to imply that DSS would be used to predict these factors, rather than include them as input or assumptions. For example, one response states, "external factors are the economic situation and the decisions by clients in industry to allocate capital expenditures. Our projects come from these factors. A DSS has no influence on these decisions."

#### 5.3.4 STATEMENT 4

MANAGERS IN MY ORGANIZATION DELEGATE THE QUANTITATIVE ANALYSIS



ASPECTS OF THEIR DECISION MAKING FUNCTIONS TO A TECHNICAL PERSON SUCH AS AN ANALYST.

The Statement is included to establish the level of direct managerial involvement with CBDS, and to identify any changes in this pattern through the availability of a DSS facility. Respondents to the AS IS Query favouring delegation of analysis to analysts take the position that managers "should coordinate the work being done, not do it all themselves." Neutral respondents offer a contingent answer: "it depends on the manager. Some are capable of quantitative analysis. Others do not have a clue. Still others have paralysis from analysis." Negative responses, i.e. those advocating analysis by managers do so for the lower management levels.

Responses to the SHOULD BE Query in agreement with the Statement that quantitative analysis should be delegated appear to express it as a self-evident point of view with a number of associated benefits, as opposed to defending it as an alternative. Neutral responses take a qualified position that delegation is proper "only if the problem is large enough or complex enough to justify such assistance."

For the IF DSS USED Query, positive responses take a broad view of management responsibilities and note that "they use the analysis only as a tool" and recommend delegation of

analysis if the data and the methodology have been jointly reviewed by both parties. One neutral respondent adopts a somewhat cynical stance: "Their commitment to serendipitous discovery would likely restrain them from using quantitative material prepared for them, and from preparing the analysis themselves." Negative responses, i.e. favouring analysis be done by managers, note that "DSS take over part of the analyst's job, therefore it should not be as important to delegate."

#### 5.3.5 STATEMENT 5

IN MY ORGANIZATION, OUTSIDE CONSULTANTS ARE HIRED FOR USE OF COMPUTER-BASED DECISION SYSTEMS.

Positive responses to the AS IS Query reflect the efficiency and cost effectiveness of using consultants to develop CBDS. Neutral responses stress the need to clearly define the problem the consultant is being asked to address. Consultants in a "staff" capacity in the firm but external to the respondent's organization are viewed with caution as part of a corporate technostructure. Negative responses view consultants with skepticism, question their motives and focus on the need for a thorough cost-benefit analysis of their services.

For the SHOULD BE Query, positive responses favouring use of consultants point to their objectivity and freedom from organizational bias, and their need to maintain professional integrity if they are to obtain further business. Neutral and negative responses refer to the expenses involved with little long-term payoff to the organization, and a preference for limiting use of consultants to specific CBDS projects as opposed to an on-going assignment.

In the IF DSS USED category, positive responses include the use of consultants as an alternative to managers learning through experience, and as catalytic agents to motivate managers in acquiring similar tools themselves. A respondent in the public sector is indifferent to the issue, stating that in either alternative, the payoff from using a DSS would be hard to determine. Respondents in organizations with in-house specialists state that fact as a reason for not using external consulting assistance; in-house development is also favoured by respondents who have had an unsuccessful experience with consultants in the past.

#### 5.3.6 STATEMENT 6

IN MY ORGANIZATION, COMPUTER-BASED DECISION SYSTEMS HAVE BEEN

USED IN THE LAST TWELVE MONTHS IN SUPPORT OF OUR DECISION MAKING ACTIVITIES.

Comments on this Statement are expected to provide insight into acceptance or rejection of CBDS in respondent organizations.

Positive responses to the AS IS Query include comments on well-designed systems which are easy to use and interactive systems which allow quick access to information. For financial decisions based upon a quantitative analysis or trade-off of options, the speed and accuracy of computer systems is offered as a strong reason for use of CBDS. Neutral responses include comments on the inability of existing CBDS to keep up with the fast-changing requirements of industry, including the rigidity of fixed output formats and data input procedures. The inadequacy of CBDS in handling subjective aspects of problems is cited as another deterrent to the use of CBDS. Negative responses focus on three factors: lack of money, lack of understanding of technology and the rigidity of approach among top management.

For the SHOULD BE Query, responses are mainly positive and reflect a view that CBDS would be useful for removing the time constraints involved in manipulating large volumes of data for inter-related variables, thus permitting managers to manage

and take action more quickly and with greater confidence. Emphasis on management education in CBDS matters is suggested as a means to achieving greater use of CBDS in organizations.

Responses to the IF DSS USED Query are in the same vein as for the SHOULD BE category. However, a respondent in a top management position, who has successfully developed a DSS model on his own, comments: "CBDS or DSS are not necessary in our organization. It should stay that way till the organization grows a lot larger."

#### 5.3.7 STATEMENT 7

IN MY ORGANIZATION, MANAGERS KNOW HOW TO MAKE EFFECTIVE USE OF COMPUTER-BASED DECISION SYSTEMS.

Descriptive comments in response to this Statement are expected to explain the competence (or lack of it) of managers in making use of CBDS, and to indicate possible routes to increasing managerial effectiveness in the use of CBDS.

Positive responses on the AS IS Query include comments to the effect that managers recently hired by the organization have brought such competence with them, that others have acquired it by a process of trial and error or in converting from

manual systems. A number of neutral responses recognize a phenomenon common in the labor stronghold of the province of B.C., that a "lot of managers came up through the ranks, and do not trust these systems." Negative responses decry the lack of managerial time available to learn CBDS principles, yet note that some managers keep personal files of statistical information which they have manually analyzed.

Comments on the SHOULD BE category are mainly positive, pointing to the need for management training and hands-on experience while cautioning that "managers would have to be sold on its value in advance of the usage." One suggestion is to demonstrate to a manager "the depth of the information available from existing reports through additional analysis, without actually modifying the information base in any way."

Neutral responses point to a possible Catch-22 situation:

"Lack of competence relates to lack of experience. The situation will change only after experience is gained."

Respondents comment on the IF DSS USED Query in a similar fashion as for the SHOULD BE category, that "a DSS might trigger recognition of information as a valuable corporate resource", while noting the need for making time available for managerial training in CBDS.

5.3.8 STATEMENT 8

IN MY ORGANIZATION, THE GOALS OF A COMPUTER-BASED DECISION SYSTEM ARE DEFINED EXPLICITLY IN TERMS OF THE DECISIONS IT WILL ASSIST.

Comments on this Statement are expected to clarify the linkage between CBDS and information required to support managerial decisions.

For the AS IS Query, positive responses range from a broad view that "CBDS should be viewed as tools to be used where they can be effective" to "if it ain't, then it's garbage in, garbage out!." Neutral responses note that systems tend to be defined in terms of their information content rather than the category of decisions they support, and that the scope of a CBDS may relate to only one part of a manager's overall problem.

Negative responses cite a variety of factors as being responsible for the situation. These include inappropriate report formats, poor documentation, difficulty in modifying systems to reflect new decision requirements, and the lack of complementarity (consistency in input and output formats) among CBDS systems. The data processing departments also are chided for procedures used for selecting new computer applications to

implement, and on their internal orientation, e.g., "systems are not user oriented but are systems oriented." A respondent from the EDP environment takes user managers to task for setting individual goals for CBDS which are inconsistent with corporate goals.

Comments on the SHOULD BE and IF DSS USED Queries are quite similar. Knowledgeable users who can define the linkage between CBDS or DSS output and their decision support requirements are viewed as the vehicle for more effective usage of these systems. Caution is expressed that DSS development should not become an end unto itself, and that this can be controlled by formulating specific goals for each application to support managerial decision making.

#### 5.3.9 STATEMENT 9

TECHNICAL ASPECTS OF COMPUTER-BASED DECISION SYSTEMS HAVE  
RETARDED THE DEVELOPMENT OF TIMELY DECISION MAKING INFORMATION  
IN MY ORGANIZATION.

This factor has been cited in the literature as a major reason for unsuccessful implementation of CBDS. Comments on this Statement are expected to highlight specific aspects of



technical problems with CBDS, and suggest possible means of reducing their impact.

Unlike most other Statements, positive responses indicate a negative conclusion, i.e. that technical considerations in CBDS have slowed the development of information for managerial decision making. The AS IS comments on this Statement represent an extensive range of concerns, not only with hardware and software specifications but also with the methods used by EDP and top management to set a corporate direction and policy for systems implementation, access and training. A respondent from the EDP environment notes, however, "I doubt that any major application would be able to avoid technical problems or delays."

Suggestions for reducing the impact of technical problems are similar for the SHOULD BE and IF DSS USED categories. Management education and familiarization with potential applications (in the form of "success stories" from other organizations) are two popular prescriptions.

There is a serious concern with degradation of response times with interactive systems; managers are apparently quite uncomfortable being seen at a computer, "doing nothing". Mechanisms for increasing the "user friendliness" of computer systems are identified as another area requiring additional

investigation; this would include consideration of streamlined procedures to allow users to quickly learn about system features, easy system access, and readily comprehend system messages for smoother interaction between system and user.

5.3.10 STATEMENT 10

IN MY WORK, I PERSONALLY MAKE USE OF COMPUTER-BASED DECISION SYSTEMS.

This Statement is unique in its direct reference to respondents, and comments are expected to identify the factors which support or obstruct their use of CBDS. Positive responses to the AS IS category identify awareness of CBDS availability and capability, together with ease of use as a major factor for CBDS usage by respondents. Neutral and negative responses indicate that either CBDS are "inappropriate" to a respondent's job function, or that budget constraints, (i.e. costs involved) and the shortsightedness of senior management are the responsible factors.

The responses for the SHOULD BE and IF DSS USED categories are quite similar. Respondents in the field of consulting services pin their hopes for increased CBDS and DSS usage on "clients who perceive the need and are willing to pay for the

use of the tools." Others look to the availability of a "satisfactory DSS which will allow access to current operational and financial aspects of corporate performance for analysis of proposed decisions." Yet another group notes that "upper management needs to change its attitudes, since it is they who set corporate policy."

#### 5.4 Statistical Analysis of Statements by Query Type

The results are tabulated for the AS IS, SHOULD BE and IF DSS Query types in Tables 3, 4 and 5 and discussed below.

##### 5.4.1 Results for AS IS Query Type

As seen in Table 3, managers respond positively only on the issue of inclusion of judgmental input in their decision making. As indicated earlier in Section 5.3.1, they do have mixed feelings on the arbitrary ways this input is used.

They respond negatively on the issues of (1) using consultants (Statement 5), (2) present managerial effectiveness with use of CBDS (Statement 7), (3) CBDS being tuned to their decision making requirements (Statement 8), and (4) personal use of CBDS (Statement 10).

Abbreviated Statement Identification	Observed Median	Chi-Square	Significance Level	Conclusion Regarding Null Hypothesis
1. Dec. mkg. allows mgrl. judgment as input.	4.061	30.229	.000	Rejected
2. Mgt. support for CBDS use.	3.115	1.429	.232	Supported
3. Dec. mkg. includes envir. factor impact.	3.750	2.057	.151	Supported
4. Quant. analysis delegated.	3.115	1.429	.232	Supported
5. Consultants hired for CBDS usage.	2.559	14.629	.000	Rejected
6. Recent use of CBDS in org.	3.136	0.914	.339	Supported
7. Mgrs. in org. effective with CBDS.	2.196	22.857	.000	Rejected
8. CBDS tuned to dec. mkg. requirements.	2.660	25.200	.000	Rejected
9. Technical barriers to CBDS use.	3.050	4.629	.031	Rejected
10. Personal CBDS use.	2.667	5.714	.017	Rejected
Overall Index		.057	.811	Supported

Table 3: Hypothesis Testing for Statements for AS IS type of Query.

Their response is essentially neutral on other issues. The Overall Index of present CBDS usage and acceptance also shows a neutral response, and may be interpreted to mean a less than enthusiastic adoption of CBDS by respondent organizations in an overall sense.

#### 5.4.2 Results for SHOULD BE Query Type

As seen in Table 4, each of the ten Statements is regarded in a positive vein in the desired state, as is the Overall Index for this category. This can be interpreted as indicating a positive future for CBDS (and as a subset, DSS) usage and acceptance in respondent organizations.

#### 5.4.3 Results for IF DSS USED Query Type

As seen in Table 5, managerial responses for eight of the ten Statements are positive when a DSS facility is assumed to be supported in an organization. For two of the ten Statements, the median response is close to being neutral. These pertain to the level of delegation of quantitative analysis to technical analysts (Statement 4), and the hiring of consultants to promote DSS usage and acceptance (Statement 5). The statistics for this hypothesis testing are based only on the

Abbreviated Statement Identification	Observed Median	Chi-Square	Significance Level	Conclusion Regarding Null Hypothesis
1. Dec. mkg. allows mgrl. judgment as input.	4.625	66.057	.000	Rejected
2. Mgt. support for CBDS use.	4.132	32.914	.000	Rejected
3. Dec. mkg. includes envir. factor impact.	4.348	44.800	.000	Rejected
4. Quant. analysis delegated.	2.313	25.200	.000	Rejected
5. Consultants hired for CBDS usage.	2.940	11.200	.001	Rejected
6. Recent use of CBDS in org.	4.100	25.200	.000	Rejected
7. Mgrs. in org. effective with CBDS.	4.139	30.229	.000	Rejected
8. CBDS tuned to dec. mkg. requirements.	3.800	4.629	.031	Rejected
9. Technical barriers to CBDS use.	3.893	6.914	.009	Rejected
10. Personal CBDS use.	4.081	18.514	.000	Rejected
Overall Index		48.057	.000	Rejected

Table 4: Hypothesis Testing for Statements for SHOULD BE type of Query.

Abbreviated Statement Identification	Observed Median	Chi-Square	Significance Level	Conclusion Regarding Null Hypothesis
1. Dec. mkg. allows mgrl. judgment as input.	4.00	23.655	.000	Rejected
2. Mgt. support for CBDS use.	3.975	31.931	.000	Rejected
3. Dec. mkg. includes envir. factor impact.	3.708	8.552	.014	Rejected
4. Quant. analysis delegated.	3.417	3.379	.185	Supported
5. Consultants hired for CBDS usage.	2.750	1.310	.519	Supported
6. Recent use of CBDS in org.	4.000	28.414	.000	Rejected
7. Mgrs. in org. effective with CBDS.	3.800	13.517	.001	Rejected
8. CBDS tuned to dec. mkg. requirements.	3.792	11.241	.004	Rejected
9. Technical barriers to CBDS use.	4.000	17.034	.000	Rejected
10. Personal CBDS use.	4.091	20.759	.000	Rejected
Overall Index	3.687	21.793	.000	Rejected

Table 5: Hypothesis Testing for Statements for IF DSS USED type of Query.

responses of the 29 managers whose DSS development is examined in this study.

The above results indicate that while managers are generally quite receptive to use of DSS, uncertainty prevails among respondents about their managerial roles with respect to making use of support services, either from technical analysts or from consultants.

## 5.5 Statistical Analysis of Perceived Gaps

Results for these tests are shown in Tables 6, 7 and 8 and discussed below.

### 5.5.1 Perceived Gap Between AS IS vs. SHOULD BE Query Types

As seen in Table 6, null hypotheses for all ten Statements and the Overall Index are rejected at 0.05 level of significance, i.e. a gap is perceived across all comparisons between the AS IS and SHOULD BE Queries. The existence of a gap recognizes a managerial perception that things are not as they should be and implies a desire for change.



Abbreviated Statement Identification	Wilcoxon Z-Score	Significance Level
1. Dec. mkg. allows mgrl. judgment as input.	-4.488	0.000
2. Mgt. support for CBDS use.	-5.232	0.000
3. Dec. mkg. includes envir. factor impact.	-4.462	0.000
4. Quant. analysis delegated.	-3.363	0.001
5. Consultants hired for CBDS usage.	-2.005	0.045
6. Recent use of CBDS in org.	-4.831	0.000
7. Mgrs. in org. effective with CBDS.	-6.334	0.000
8. CBDS tuned to dec. mkg. requirements.	-5.373	0.000
9. Technical barriers to CBDS use.	-4.539	0.000
10. Personal CBDS use.	-5.086	0.000
Overall Index	-6.945	0.000

Table 6: Hypothesis Testing of Perceived Gap Between AS IS and SHOULD BE Queries at 0.05 Level of Significance.

### 5.5.2 Perceived Gap Between SHOULD BE vs. IF DSS USED Query Types

As seen in Table 7, for seven of the ten Statements, no gap is perceived between the SHOULD BE and IF DSS USED states. The existence of a gap suggests that a DSS may not be the vehicle to reach the SHOULD BE state. Gaps are perceived (at a 0.05 level of significance) in the level of managerial input to organizational decision making (Statement 1), and the degree to which explicit use of environmental factors is made as an input to decision making (Statement 3). A possible interpretation of these gaps is that while respondents perceive that more is required to be done in these areas (as shown by the SHOULD BE responses), they will not be done just because a DSS is being used.

The absence of a gap for the Overall Index, however, indicates managerial perception that a DSS facility is a promising vehicle with which to reach the SHOULD BE state.

### 5.5.3 Perceived Gap between AS IS and IF DSS USED Query Types

According to the research hypothesis, responses to these two Query types would indicate a similar score, or a higher score for the IF DSS USED type of Query. The results of the analyses are summarized in Table 8.

Abbreviated Statement Identification	Wilcoxon Z-Score	Significance Level
1. Dec. mkg. allows mgrl. judgment as input.	-2.621	.009*
2. Mgt. support for CBDS use.	-0.356	.722
3. Dec. mkg. includes envir. factor impact.	-2.667	.008*
4. Quant. analysis delegated.	-1.580	.114
5. Consultants hired for CBDS usage.	-1.376	.169
6. Recent use of CBDS in org.	-0.102	.919
7. Mgrs. in org. effective with CBDS.	-0.824	.410
8. CBDS tuned to dec. mkg. requirements.	-0.578	.563
9. Technical barriers to CBDS use.	-0.338	.735
10. Personal CBDS use.	-0.840	.401
Overall Index	-1.171	.241

Table 7: Hypothesis Testing of Perceived Gap Between SHOULD BE and IF DSS USED Queries at 0.05 Level of Significance.

\* Indicates results are statistically significant at the .05 level.

Abbreviated Statement Identification	Wilcoxon Z-Score	Significance Level
1. Dec. mkg. allows mgrl. judgment as input.	-0.314	.754
2. Mgt. support for CBDS use.	-3.808	.000*
3. Dec. mkg. includes envir. factor impact.	-1.938	.055
4. Quant. analysis delegated.	-0.596	.593
5. Consultants hired for CBDS usage.	-1.538	.124
6. Recent use of CBDS in org.	-3.823	.000*
7. Mgrs. in org. effective with CBDS.	-3.615	.000*
8. CBDS tuned to dec. mkg. requirements.	-3.456	.001*
9. Technical barriers to CBDS use.	-2.856	.004*
10. Personal CBDS use.	-3.724	.000*
Overall Index	-4.469	.000*

Table 8: Hypothesis Testing of Perceived Gap Between AS IS and IF DSS USED Queries at 0.05 Level of Significance.

\* Indicates results are significant at the .05 level.

Perceived gaps are identified by DSS manager-developers to indicate the extent and nature of changes implied by DSS use. Firstly, there would be greater management support for the use and acceptance of DSS (Statement 2) than is the case at present with CBDS (computer-based decision systems); secondly, there would be more frequent use of DSS (Statement 6) than is done now with CBDS; thirdly, managers would be more effective in the use of DSS (Statement 7) than they are now with CBDS; fourthly, DSS would be more tuned to specific decision making requirements (Statement 8) than are CBDS at present; fifthly, there would be fewer technical barriers to use of computer-based systems with DSS (Statement 9) than at present with CBDS, and furthermore, more of the respondents would use DSS (Statement 10) than they do now with CBDS.

A gap is also perceived across the Overall Index values; this may reflect a managerial perception that DSS, if available and supported in their organizations, would be used and accepted to a greater extent than CBDS are at present. Areas in which gaps are not perceived are perhaps just as worthy of note. No increase in the level of managerial input (Statement 1) or use of environmental factors in decision making (Statement 3) is noted, i.e., that these factors are essentially independent of whether or not a DSS is used. As well, no changes are noticed in the level to which managers delegate quantitative analysis of decision making to technical analysts (Statement 4), or in

the level of usage of consultants to promote use of DSS (Statement 5). These factors represent support services to managers, and the results indicate an uncertainty among managers as to their productive use.

#### 5.6 Relationship Between AS IS Type Statements and Situational Variables

Relationships between the AS IS Statements and situational variables, statistically significant at the 0.05 level, are stated in Table 9; taken together with related descriptive statistics, they indicate that:

- (a) The level of management support for CBDS increases with the level of technical and user support for CBDS.
- (b) The level at which consultants are hired for introduction and use of CBDS is highest when the competition faced by an organization is at the lowest level.
- (c) The level of CBDS use in an organization increases with the level of organizational (technical and user) support of CBDS in the organization.
- (d) The level to which managers are effective in the use of CBDS is related to their knowledge levels for CBDS prior to enrolment in the MBA program. However, at their present level of knowledge (after 1-2 years in the

Abbreviated Statement Identification	Situational Variable	Chi-Square	Significance Level
2. Mgt. support for CBDS use.	Level of CBDS support in org.	13.874	.001
2. Mgt. support for CBDS use.	DSS course enrolment	7.230	.007
5. Consultants hired for CBDS usage.	Competition with other org.	7.514	.023
5. Consultants hired for CBDS usage.	DSS course enrolment	3.994	.046
6. Recent use of CBDS in org.	Level of CBDS support in org.	8.052	.018
6. Recent use of CBDS in org.	DSS course enrolment	4.674	.031
7. Mgrs. in org. effective with CBDS.	Pre-MBA CBDS expertise	8.913	.012
7. Mgrs. in org. effective with CBDS.	Level of CBDS support in org.	9.069	.011
8. CBDS tuned to dec. mkg. requirements.	Level of CBDS support in org.	7.086	.029
10. Personal CBDS use.	Pre-MBA CBDS expertise	8.467	.014
10. Personal CBDS use.	Present CBDS expertise	7.603	.022
10. Personal CBDS use.	Attitude towards CBDS	6.997	.031
10. Personal CBDS use.	Level of CBDS support in org.	12.446	.002

Table 9: Hypothesis Testing of Relationships between Statements for the AS IS type of Query and Situational Variables via Kruskal-Wallis ANOVA Test. Cutoff level for significance is 0.05.

program) this relationship between effectiveness of use and CBDS knowledge is no longer statistically significant. This reflects the movement of the CBDS knowledge levels towards the upper end of the scale, with less overall separation between levels. Also, managerial effectiveness with CBDS is greater for higher levels of organizational support for CBDS.

- (e) The level to which CBDS is tuned to specific decision making requirements increases with the level of CBDS support in the organization.
- (f) The level of personal use of CBDS by respondents increases with higher levels of (1) managerial knowledge of CBDS, (2) overall attitude towards CBDS, and (3) organizational support available for CBDS.
- (g) In analyzing the responses from those with hands-on DSS development experience through the MIS/DSS course vs. those who have not, the differences are statistically significant for the levels of top managerial support for CBDS, for the use of consultants to support use and acceptance of CBDS and for increased use of CBDS. In each case, the levels are higher for those enrolled in the MIS/DSS course.

#### 5.7 Analysis of Perceived Gaps Between AS IS, SHOULD BE and IF DSS USED Queries by Situational Variables



Perceived Gap for Statement	Situational Variable	Chi-Square	Significance Level
1. Dec. mkg. allows mgrl. judgment as input.	Present knowledge of CBDS	7.285	.026
1. Dec. mkg. allows mgrl. judgment as input.	Sex of respondent	4.052	.044
2. Mgt. support for CBDS use.	DSS course enrolment	4.272	.039
3. Dec. mkg. includes envir. factor impact.	No. of years in present position	8.180	.042
4. Quant. analysis delegated.	DSS course enrolment	6.436	.011
6. Recent use of CBDS in org.	Sex of respondent	5.315	.021
7. Mgrs. in org. effective with CBDS.	Office status of organization	6.813	.033
9. Technical barriers to CBDS use.	Sex of respondent	5.676	.017
10. Personal CBDS use.	Sex of respondent	9.184	.002
10. Personal CBDS use.	Field of highest educ. level	12.837	.046
10. Personal CBDS use	Level of CBDS support in org.	9.584	.008
Overall Index	Respondent attitude towards CBDS	7.166	.028
Overall Index	Sex of respondent	4.421	.036

Table 10: Hypothesis Testing of Relationships between Perceived Gap for AS IS vs. SHOULD BE and Situational Variables via Kruskal-Wallis ANOVA Test.

5.7.1 Perceived Gap for AS IS vs. SHOULD BE Queries Analyzed  
by Situational Variables

The significant relationships for perceived gap between AS IS vs. SHOULD BE Queries and the situational variables are shown in Table 10 and can be summarized as follows:

- (a) The gap perceived between AS IS and SHOULD BE for Statement 1, i.e., that decision making allows managerial judgment as input, is statistically significant when analyzed by the manager's knowledge level of CBDS and by the sex of the manager. The gap decreases as a manager's knowledge of CBDS increases, and is higher for female managers.
- (b) The gap perceived for Statement 3, i.e. the explicit use of environmental factors in decision making, is statistically significant when analyzed by the length of experience in the present position. The gap decreases with increasing job experience.
- (c) The gap perceived for Statement 6, i.e. the recency of use of CBDS, is statistically significant when analyzed by the sex of manager. It is greater for female managers than male managers.
- (d) The gap perceived for Statement 7, i.e. for managerial effectiveness with CBDS, is significant when analyzed by status of workplace, e.g., head office or

branch office. The gap is greater for managers in branch offices than for those in head office locations.

- (e) The gap perceived for Statement 9, i.e. the effect of technical barriers on the use of CBDS, is greater for female managers.
- (f) The gap perceived for Statement 10, i.e. the level of personal use of a CBDS, is statistically significant when analyzed by the sex of the respondents (it is higher for females), the field in which the highest educational level (prior to MBA enrolment) has been achieved (it is lowest for engineers), and the present level of organizational support for CBDS (it decreases with increasing support).
- (g) At the Overall Index level, the gap perceived in the usage and acceptance of CBDS is statistically significant when analyzed by the attitude that respondents have towards CBDS and by the sex of the manager. It is greatest for the most positively oriented managers and for female managers.
- (h) In analyzing the difference in responses from those who have had hands-on DSS development experience vs. those who have not, the gap perceived is statistically significant for Statements 2 and 4, i.e. regarding management support for CBDS use and the level to which quantitative analysis is delegated for CBDS vs. DSS. In each case,

the gap is perceived to be greater by those with DSS development experience.

### 5.7.2 Analysis of Perceived Gap Between AS IS and IF DSS USED

#### Type of Queries by Situational Variables

The statistically significant relationships for Perceived Gap between AS IS and IF DSS USED as one variable set, and situational variables as the second set of variables are shown in Table 11 and may be summarized as follows:

- (a) The gap perceived for Statement 2, i.e. management support for CBDS vs. DSS use, is statistically significant when analyzed by the sex of the respondents and the field in which their highest educational level is achieved.

The gap is perceived to be highest by female managers and by managers educated in Business Administration.

- (b) The gap perceived for Statement 6, i.e. recent use of CBDS vs. DSS, is statistically significant when analyzed by the sex of the respondent and the type of organizational workplace, (i.e. head-office, branch office, etc.).

Perceived Gap for Statement	Situational Variable	Chi-Square	Significance Level
2. Mgt. support for CBDS use.	Sex of respondent	4.160	.041
2. Mgt. support for CBDS use.	Field of highest educ. level	9.792	.044
6. Recent use of CBDS in org.	Sex of respondent	5.592	.018
6. Recent use of CBDS in org.	Office status of organization	8.868	.012
7. Mgrs. in org. effective with CBDS.	Sex of respondent	5.399	.020
7. Mgrs. in org. effective with CBDS.	Office status of organization	14.410	.001
7. Mgrs. in org. effective with CBDS.	Org. work function	8.764	.013
8. CBDS tuned to dec. mkg. requirements.	No. of years in present position	6.333	.042
8. CBDS tuned to dec. mkg. requirements.	Field of highest educ. level	11.286	.024
8. CBDS tuned to dec. mkg. requirements.	Office status of organization	8.909	.012
8. CBDS tuned to dec. mkg. requirements.	Org. work function	8.764	.013
10. Personal CBDS use.	Time pressures in org.	6.656	.036
10. Personal CBDS use.	Office status in org.	6.480	.039
Overall Index	Sex of respondent	5.072	.024
Overall Index	Field of highest educ. level	11.262	.024
Overall Index	Office status of org.	9.249	.010
Overall Index	Org. work function	7.107	.029

Table 11: Hypothesis Testing of Relationships between Perceived Gap for AS IS vs. IF DSS USED and Situational Variables via Kruskal-Wallis ANOVA Test.

The gap is perceived to be highest by female managers and also by managers employed in a branch office location.

- (c) The gap perceived for Statement 7, i.e. managerial effectiveness with CBDS vs. DSS, is statistically significant when analyzed by the respondent's sex, type of organizational workplace (head office, branch office, etc.) and type of organizational work function (staff or line management).

The gap is perceived to be highest by female managers, by managers who are employed in a branch office location and by managers whose function is one of line management.

- (d) The gap perceived for Statement 8, i.e. CBDS vs. DSS tuned to specific managerial decision making requirements, is statistically significant when analyzed by respondent's field of highest educational level, type of organizational workplace and work function, and length of managerial experience.

The gap is perceived to be highest for managers with degrees in Education and Business Administration, managers who are employed in branch offices, and managers with the longest experience in their present position.

- (e) The gap perceived for Statement 10, i.e. personal use of CBDS vs. DSS, is statistically significant when analyzed by levels of time pressure in a respondent's organization, and the type of organizational workplace.

The gap is perceived to be greatest by organizations encountering lower levels of time pressures, and managers employed in a branch office location.

- (f) The situational variables which depict a significant relationship with the Perceived Gap in the Overall Index, and thus may be interpreted as being of general significance, are the respondent's sex, field of education in which highest level achieved, and the type of organizational workplace and work function.

The gap in Overall Index is perceived to be highest for female managers, managers with training in Business Administration and managers employed in branch offices or as line management.

## 5.8 Summary

This chapter presents the results of investigating organizational usage and acceptance of computer-based decision

systems. Key issues are formulated as Statements on which respondents express an opinion under three scenarios: as the situation presently exists in their organizations, as it should be in a desired sense, and if a DSS facility were supported for use in their organizations. Differences in responses to a Statement for any two of these scenarios are viewed as "perceived gaps" for that Statement. Statements and perceived gaps are analyzed by a number of situational variables encompassing managerial and organizational characteristics.

Several interesting results emerge from this analysis. The Overall Index of present CBDS usage and acceptance indicates a less than enthusiastic adoption of CBDS by respondent organizations. The outlook is, however, positive for the future of CBDS as managers appear to want a change from the present situation. The availability of DSS improves on the present state, but indicates an uncertainty among managers on how to make use of technical analysts or consultants in this area. Managers who have developed DSS respond more positively on issues regarding the present management support for CBDS, for use of consultants and for use of CBDS in their organizations. This may reflect their own attitudes towards CBDS as a useful managerial tool.



CHAPTER VI: DISCUSSION OF RESULTS: MANAGER-DEVELOPED  
DSS AND ALTER'S IMPLEMENTATION RISK FACTOR  
METHODOLOGY

6.1 Introduction

In this chapter, twenty-one manager-developed DSS are analyzed in the context of implementation risk factors and offsetting implementation strategies as identified in the Alter methodology. A descriptive review of the twenty one DSS is followed by hypothesis testing for problems associated with the implementation risk factors, and an analysis of the inter-relationships between these problems. An overall implementation problem index is formulated as an aggregated measure of the incidence of implementation problems; individual problems are compared with the index. The possibility of additional problems and risk factors (beyond those identified by Alter) affecting manager-developed DSS is explored through a review of comments from managers who develop these DSS. Hypothesis testing is then done for the Alter implementation strategies included in this study as being relevant to the manager-developed DSS environment. An examination of the relationship

between implementation strategies and implementation problems is followed by an analysis of the interrelationship between the various implementation strategies. The significance of DSS developmental variables, composed of organizational and project attributes is noted; the relationship of these DSS related variables with implementation strategies, implementation problems and with other DSS situational variables is explored. Finally, the insight gained by DSS manager-developers is reviewed as occurring in a variety of forms and their attitude to future use of the DSS approach in managerial problem-solving is noted.

## 6.2 A Descriptive Review of Manager-Developed DSS

Write-ups for the DSS examined in this study are included as Appendix 3, and collectively reflect the wide variety of problems tackled by managers using a DSS approach. For each project, the nature of the problem is identified and followed by a brief description of the input and output components of the models. For models encountering developmental difficulties, this is noted in the form of anecdotal evidence from the participants. For projects rated "successful" by their developers, the write-ups concentrate on identifying the information used and insights derived from the modelling exercise.

Twenty-nine managers and professionals participate in the development of twenty-one DSS projects; eight projects are undertaken by two-person teams, and thirteen projects are tackled on an individual basis.

### 6.3 DSS Project Characteristics

#### 6.3.1 Background Information

The developer-managers here who develop DSS do so as part of a university MBA course on decision support systems. They are given instruction on IFPS (Interactive Financial Planning System), a DSS language available on the university's main-frame computer system in an interactive mode. Following this instruction, they are asked to consider a problem normally of significance to their organization, and use a DSS approach to solving the problem to their satisfaction. Project development is to be terminated at end-of-term, or earlier if problem-solving is completed. The results of their development effort are documented in the form of project reports and handed in to the course instructor. Individuals are provided with a set of reference manuals and allocated a computer usage budget. The two-person teams are formed through an informal pooling of interest in a problem or on the basis of interpersonal compatibility.

Project Number	Project Title	Team Size
1	A DSS for Personal Financial Planning	2
2	A Company in Insolvency	1
3	An Inventory Problem	2
4	A Corporate Budgeting Model	2
5	New Product Introduction	1
6	A Model for Human Resources Planning	1
7	Real Estate Investment Analysis	1
8	Staffing of Customer Service Functions	1
9	Manpower Planning	2
10	Group Life Insurance Plan Evaluation	1
11	School District Enrollment Forecasting	2
12	A Merchandise Budgeting System	2
13	Analysis of Corporate Overheads	1
14	Economic Analysis of Land Development Projects	1
15	Planning Guide for a Small Business	1
16	Rate Calculations for a Health and Welfare Trust	1
17	Economic Analysis of Engineering Projects	2
18	Resource Allocation in a School Board	1
19	Profit Forecasting for a Consulting Service	1
20	Commercialization of an Invention	1
21	An Operating Budget for a Community Newspaper	2

Table 12: Manager-Developed DSS Projects  
By Title and Teams Size.

Table 12 lists the Project titles by team size. Projects are assigned sequence numbers for ease of reference, and correspond to those shown in Appendix 3.

### 6.3.2 Type of DSS Developed

Manager-developers successfully categorize their DSS projects within the Alter taxonomy. The distribution of DSS types in this study is compared in Table 13 with results reported by Alter (1979) and in a Canadian study by Grindlay et al (1981). Two significant differences between this study and the other two are in the absence of any Optimization models and the preponderance of Suggestion models. The use of optimization techniques has long been regarded as a sophisticated application of management science, and "optimization" is generally offered as an advanced feature in DSS languages. For these reasons, it is not surprising that in developing their first DSS model in a DSS language relatively new to them, manager-developers have not attempted problem-solving via optimization techniques. The high percentage of Suggestion models in this study suggests an emphasis among this group of manager-developers on a tool which mechanizes previously manual work for a fairly structured task, with the results leading to a specific suggested decision.

DSS Type	This Study		Alter Study		Canadian Study	
	No.	%	No.	%	No.	%
File Drawer	5	17.2	7	12.5	8	6.1
Data Analysis			8	14.3	44	33.6
Analysis Information			3	5.4	5	3.8
Accounting	9	31.0	11	19.6	26	19.6
Representational	4	13.7	12	21.4	23	17.5
Optimization	0	0	6	10.4	22	16.7
Suggestion	11	37.9	9	16.0	3	2.2

Table 13: Comparison of Distribution of DSS Types in Three Studies.

The combination of categories in reporting statistics for this study reflects the overlap in generic operations within certain manager-developed DSS.

### 6.3.3 Decision Type Modelled

Decisions modelled in the DSS projects are grouped into two types. Routine or recurrent decisions account for 21 of the 29 projects; ad hoc or non-recurring decisions are modelled in the rest of the projects.

### 6.3.4 Functional Aspect of Organization Represented

The distribution of the organizational functions in which the DSS would be primarily used is as follows: Corporate (or multi-function) applications account for 31.0 percent. Production applications account for 10.3 percent, Finance applications for 37.9 percent and Administration (including Personnel) for the remaining 20.7 percent.

### 6.3.5 Time Horizon of DSS Projects

Over half of the DSS projects (51.7 percent) reflect a development focus for the short term time horizon of one year. Just over a third (34.5 percent) of the projects use a one-to-five year time horizon, and the rest (13.8 percent) model problems incorporating a longer time horizon.

## 6.4 Hypothesis Testing of Alter's Implementation Risk Factor

### - Related Problems

This study investigates the occurrence of implementation problems previously identified by Alter. For each such problem, a null hypothesis is formulated that it (the problem) is equally likely to be present as to be absent.

Summaries of the statistical results for these tests of hypothesis are shown in Tables 14 and 15, and are discussed below separately for each implementation factor-related problem.



Problem Description	Frequency of "Not at all" Responses (Percent)	Median Score	Chi-Square Value	Significance Level
1. Multi-User Commun. Problems	62.1	1.306	1.690	.194
2. Multiple Interests	58.6	1.353	0.862	.353
3. Overoptimism	34.5	2.063	2.793	.095
4. Need for Addl. Computing	65.5	1.263	2.793	.095
5. Computer Terminal Problems	13.8	3.063	15.207	.000
6. DSS Language Problems	10.3	2.867	18.241	.000
7. Project Not Relevant	51.7	1.467	0.034	.853
8. Deadline Expiry	65.5	1.263	2.793	.095
9. Lack of Commitment to DSS	55.2	1.406	0.310	.577

Table 14: Hypothesis Testing for Implementation Problems.

Kruskal-Wallis ANOVA Test by Ranks vs. Team Size		
Problem Description	Chi-Square Value	Significance Level
1. Multi-users Commun. Problems	6.950	.005
2. Multiple Interests	15.433	.000
3. Overoptimism	3.218	.073
4. Need for Addl. Computing	0.827	.363
5. Computer Terminal Problems	0.089	.766
6. DSS Language Problems	0.249	.617
7. Project Not Relevant	0.009	.924
8. Deadline Expiry	1.553	.213
9. Lack of Commitment to DSS	0.211	.646

Table 15: Kruskal-Wallis ANOVA Test of Significance of Implementation Problem When Analyzed by Team Size.

6.4.1 Problem 1: Multiple Users or Implementers, Causing  
Communication Problems

Alter's discussion of this problem refers to communication problems affecting users or implementers of a particular DSS. For this study, such problems are more likely to arise among developers, since the majority of the developers are also users of their models. This is reflected in comments from 2-person teams that scheduling of specific times for project work is often difficult, since their regular roles as managers in their respective organizations have a higher priority than DSS project work. One 2-person team attempts to circumvent this scheduling problem by independently accessing their DSS model on the university computer system at their own convenience. Each team member encounters considerable difficulty in interfacing with different parts of their common model because of changes independently implemented by their partner, or in a more typical situation, because the changes are still being "debugged." Compromise on several fronts is required, including an agreement on more formal change procedures for the model. A common "working" version of the model is maintained separately from versions in development. A re-assessment of their overall DSS goals is also required to reflect the slippage in project schedule resulting from these difficulties. Communication problems also result when one developer is unfamiliar with the problem environment being modelled and its

related "jargon" for describing interrelationship of variables.

The term "communication problem" is interpreted in a different way by several manager-developers, including those working individually on their projects. They are concerned with their periodic inability to access the computer system via communication lines or the slow response from the computer system while they sit at a terminal keyboard.

In a majority of the DSS projects, the communication problems as perceived by Alter is minimized through mutual compromise and cooperation. In Project No. 9 (see Appendix 3 for write-up), for example, "the project was initiated by Ms. M with a written outline of the problem. This served two purposes; it identified the boundaries of her overall problem to be tackled within the DSS, and it helped Mr. N understand the objectives of the exercise."

### Statistical Results

This problem (coded in SPSS as variable PR1) is a minor one, as 62.1 percent of manager-developers give it a score of 1.0, that is they regard it as not having any impact on their DSS development; another 24.1 percent give it a score of 2.0,

i.e. regard this problem as having only a small impact. The median score for PR1 is 1.306. The test for the null hypothesis gives a chi-square value of 1.690 with a significance level of 0.194; the null hypothesis for PR1 is thus supported, i.e. that the problem is as likely to occur as not to occur. The associated null hypothesis for significance of scores for PR1 when analyzed by levels of team size is tested by the Kruskal-Wallis ANOVA procedure; it gives a chi-square value of 6.950 with a significance level of .075, and this null hypothesis is rejected, i.e. there is a statistically significant relationship between the levels of PR1 and team size. The level of PR1 is greater for the larger team size.

#### 6.4.2 Problem 2: Multiple Users or Implementers Leading to Inability to Incorporate Multiplicity of Interests

Alter notes that individual interests are harder to accommodate in a DSS as the number of users or implementers increases. In this study, manager-developers perform in both of these roles.

A general comment heard from 2-person teams is that they cannot accomplish as much as they had originally intended. They usually compromise by agreeing on a less ambitious scope

for their project, one which can be completed within the established deadline. This is for example the case with the planned use of DSS language facilities to generate flexible report formats; the compromise is in making use of system default options.

Some projects involve external users, and here the problem is more evident. In Project No. 20, concerning the marketing of an invention, Ms. BB develops a DSS model to consider the financial implications of adding a new lighting system to the manufacturing operations of a client company. This lighting system has been brought to Ms. BB's client by an inventor, who wishes to exercise control over the commercialization of his invention as well as obtain royalties from the sales of the product. Disagreement between the inventor and Ms. BB's client on the release of data which has been confidential to each party, for use in the DSS model, leads to the original DSS model being set aside. A more limited analysis is subsequently undertaken by Ms. BB. A frequent approach to reaching consensus is by formally documenting the scope of the planned effort. In Project 9, Mr. N uses a descriptive problem statement to develop a list of the parameters involved, as well as to identify their interrelationships. He notes: "once consensus was reached with Ms. M and the parameters established, there was no further problem with the scope of the project." Ms. M is more appreciative of Mr. N's efforts at this stage.

"If he hadn't outlined the logic, I doubt if I could have continued."

### Statistical Results

The problem (coded in SPSS as variable PR2) is a minor one; 58.6 percent of the manager-developers regard it as not having any impact at all on their DSS development; another 34.5 percent place it in the category of having a small impact. The median score for PR2 is 1.353, and the test for the null hypothesis for PR2 gives a chi-square value of 0.862 with a significance level of 0.353. The null hypothesis that this problem is just as likely as not to occur is supported.

The associated null hypothesis for effect of team size is tested by the Kruskal-Wallis ANOVA procedure, and gives a chi-square value of 15.433 with a significance level of .000. The null hypothesis is rejected, i.e. there is a significant difference in scores for PR2 when analyzed by levels of team size. The level of PR2 is greater for the larger team size.

6.4.3 Problem 3: Overoptimism Among DSS Designers or Users  
During Some Phase of Development

Alter (1980, p. 133) notes that "the recurring pattern here is simply overoptimism on the part of system designers and advocates, who assume that non-computer personnel will figure out how to use computerized systems to solve their business problems." Manager-developers cope with this problem in a variety of ways. Frequently the DSS being developed is scaled down in scope as the learning curve for the DSS system proves shallow; often, longer hours are spent in debugging a model. In Project 9, where one of the developers is quite confident that the model will confirm her belief that her office is understaffed for the workload carried, "the unexpected output led to considerable thinking about why we got the answers we did."

Other examples of overoptimism include an attempt to model a business function in extreme detail, with the ensuing recognition that "models are only an abstraction of reality -- not all variables can be quantified, anticipated or included to duplicate actual business operations."

### Statistical Results

For this problem (coded in SPSS as variable PR3), 34.5 percent of manager-developers regard it as having no impact at all on their DSS development. Another 27.6 percent say that it has only a small impact, and a further 31.0 percent put it in the category of having a moderate impact. The median score for PR3 is 2.063, and the test for the null hypothesis that this problem is just as likely as not to occur gives a chi-square value of 2.793 with a significance level of 0.095. The null hypothesis for PR3 is supported.

The associated null hypothesis for team size is analyzed by the Kruskal-ANOVA procedure, and supported at the .05 level of significance. There are no statistically significant differences in scores for PR3 when analyzed by levels of team size.

#### 6.4.4 Problem 4: Need for Additional Computer Time

##### Allocation for Project

Alter's view of management support for a DSS project includes authorization for sufficient computer resources. Denial of such authorizations, particularly beyond the levels initially approved, can be interpreted as lack or loss of support for the project.



In this study, DSS manager-developers are allocated an initial level of computer resources, in terms of a dollar value of central processor time and disk storage space. In most instances, projects are completed within this limit. Although requests for additional computer resources are granted, it is considered useful to identify the reasons for overrunning the project budget.

Overruns are associated with the continued growth of models in size and corresponding storage of multiple versions on disk, and exploring the use of DSS language commands and options. The use of the risk analysis command feature is identified as a particular problem in this context. The developer of Project No. 5 comments: "One consequence of the large number of iterations in my simulation model was the rapid exhaustion of budgeted computer time." He also advises other managers planning to use these sophisticated DSS commands to carefully monitor their DSS expenditures, in order to develop guidelines for an effective number of iterations to use for their problem.

### Statistical Analysis

This problem (coded as PR4 in SPSS) elicits a 65.5 percent response in the "not at all" category, and another 13.8 percent state that the problem has only a small impact on their

DSS development. The median score for PR4 is 1.263, and the test for the null hypothesis that this problem is as likely as not to occur gives a chi-square value of 2.793 with a significance level of 0.095. The null hypothesis is supported. For the associated hypothesis regarding team size, PR4 is not found to have a statistically significant relationship with team size.

#### 6.4.5 Problem 5: Technical Problems with Computer Terminal

##### Usage

Alter considers as a potential problem the extent to which existing technology tends to become a binding constraint and prevents the development of DSS. One such technical problem concerns the use of the computer terminal, normally the means of communication between a DSS developer and the DSS model.

Three type of technical problems are noted by DSS developers in this study. The one causing the greatest frustration is simply not being able to access the computer system at the university from off-campus locations using communication lines, at times of personal convenience. A serious contention develops near the end-of-term deadline for remote access "ports" to the computer system; some developers resort to dialling-in during the early hours of the morning. As one

disgruntled individual notes: "Access, yes; convenience, no."

The second type of problem is a periodically slow response from the computer system to DSS commands issued at the terminal. Mr. U of Project No. 14 notes: "There I was sitting at the terminal, for minutes on end, doing nothing but staring at the screen." Ms. Z's problems with system response time arise during a demonstration of her model for her users. The users are not convinced that using her model in an interactive mode is a particularly efficient procedure.

The third type of terminal-related problem concerns system error-messages appearing on the CRT screen. Ms. O in Project No. 10 finds these messages "undecipherable", and her reaction to terminal procedures "not so obvious." Ms. E in Project No. 3 discovers to her chagrin that information entered in "upper case" is treated differently from the same information in "lower case" and requires re-entry of a large amount of data. Not everyone is impatient with the process of becoming familiar with terminal operating procedures; a few accept the premise that time, and experimentation is required to feel comfortable at the keyboard.

## Statistical Results

For problems with computer terminal operations (coded in SPSS as PR5), only 13.8 percent of the manager-developers state that this does not impact DSS development at all. The median response score is 3.063 (i.e. a moderate level), and the test for the null hypothesis that this problem is equally as likely as not to occur gives a chi-square value of 15.207 with a significance level of 0.000. The null hypothesis is rejected, and from examining the descriptive statistics, this problem is more than likely to occur. For the associated hypothesis, no statistically significant relationship is found to exist between the extent of impact of this problem on DSS development and team size.

### 6.4.6 Problem 6: Unfamiliarity with Specifications of DSS Language, Leading to Mistakes

According to Alter's viewpoint, a development effort for a new system has much in common with a research effort. For each of the manager-developers in this study, the development of a DSS is a first-time effort. Each person receives the same amount of DSS language information, and is provided with the same reference material and systems documentation.

A majority of manager-developers agree that this project is a learning exercise, given their previous unfamiliarity with computer languages and systems development. For Ms. O in Project 10, however, it is simply "too complicated a setup for such a short exercise." In contrast, Mr. I in Project No. 5 who has previously programmed computers in FORTRAN, takes a very different approach in using his DSS language reference material. He concentrates on understanding the overall problem-solving approach used with the DSS language, rather than the syntax of each DSS command. He notes that this procedure allows him to see patterns in the ways different DSS commands are used with each other.

The DSS reference manual is soundly criticized for its lack of organization, leading to difficulties in manager-developers locating specific materials of interest to them.

### Statistical Results

Only 10.3 percent of manager-developers state that they have no problems at all with the use of the DSS language. The median response score is 2.867. The test for the null hypothesis that this problem is as likely as not to occur gives a chi-square value of 18.241 with a significance level of 0.000. The null hypothesis for this problem is rejected.

From the descriptive statistics the conclusion is the problem is more likely than not to occur. For the associated hypothesis regarding effect of team size, no significant relationship is found to exist between the extent of impact of this problem on DSS development and team size.

#### 6.4.7 Problem 7: Lack of Relevance of Project to My Organization

Alter (1980, p. 159) notes that "the risk of having non-existent or unwilling users is especially high for systems that are not initiated by their potential users." In this study, manager-developers are encouraged to develop DSS of relevance and interest to their organization. However, it is recognized that in 2-person teams this would not be possible if each represents a different organization. Thus one of the members in a 2-person team cannot be considered a user of the system, nor will the problem being modelled necessarily have any organizational relevance for him.

Lack of project relevance is also interpreted as arising from the inability to transfer a model to a work environment for reasons of incompatibility of computer systems and lack of on-site model-development support.

## Statistical Analysis

Over 50 percent of manager-developers state that this problem has no impact on their DSS development. Several managers view their projects as a learning experience, measured not just in terms of short term benefits from completing a course assignment, but also in terms of acquiring a managerial tool for use in the long term. The median score for this problem is 1.467, and the test for the null hypothesis that this problem is as likely as not to occur gives a chi-square value of 0.034 with a significance level of 0.853. The null hypothesis is thus supported. For the null hypothesis regarding effect of team size, no significant relationship is observed between the extent to which this problem impacts DSS development and team size.

### 6.4.8 Problem 8: Project Deadline Expired

This problem is related to the issue of management support for DSS development; this support may be offered not just for a given amount of computer resources as in Problem 4, but may be offered for a specific time period as well. Manager-developers in this study face a deadline in the form of an end-of-term date.

### Statistical Analysis

For 65.5 percent of manager-developers, this problem has no impact at all on their DSS development. The median score is 1.263 for this problem. For the null hypothesis that this problem is as likely as not to occur, the test gives a chi-square value of 2.793 with a significance level of 0.095. The null hypothesis for this problem is thus supported. For the associated hypothesis regarding effect of team size, no significant relationship is observed between the levels of team size and the extent to which this problem impacts on DSS development.

#### 6.4.9. Problem 9: Lack of Commitment to Use the DSS Being Developed

Alter notes that DSS developed with little active participation by users face the problem that these users may show a lack of commitment to use the systems developed for them. Manager-developers in this study are encouraged to develop DSS which are of interest and value to them in an organizational context.

Two types of comments are noted in this problem area. In instances where users for a DSS model are external to the



DSS development teams, they often do not value the models demonstrated, or request changes to a degree that the DSS manager-developer teams start to lose interest in their projects. The second comment is similar to one made for Problem 7 concerning lack of relevance of a DSS project. A lack of commitment is indicated by manager-developers who feel they cannot transfer their model to their own computer system at work.

### Statistical Results

This problem has no impact on the DSS development efforts of 55.2 percent of the manager-developers. The median score for this problem is 1.406, and for the null hypothesis that this problem is as likely as not to occur, the test gives a chi-square value of 0.310 with a significance level of 0.577. The null hypothesis for this problem is supported. For the associated hypothesis regarding team size, no significant relationship is observed in the difference in scores for this problem when analyzed by levels of team size.

No.	KRUSKAL-WALLIS ANOVA TEST		Chi-Square Value	Significance Level
1		Multiple User Interests	9.248	.010
	By	Multi-User Communication Problems		
2		Multi-User Communication Problems	5.757	.016
	By	Multiple User Interests		
3		Overoptimism Among Developers	8.551	.003
	By	Multiple User Interests		
4		Multi-User Communication Problems	11.851	.003
	By	Overoptimism Among Developers		
5		Multiple User Interests	10.557	.005
	By	Overoptimism Among Developers		
6		Lack of Commitment to Use DSS	7.232	.027
	By	DSS Project not Relevant		
7		DSS Project not Relevant	7.014	.030
	By	Lack of Commitment to Use DSS		

Table 16: Interrelationship Between Implementation Problems.

### 6.5 Relationship Between Implementation Risk Factor-Related Problems

The results which are significant at the .05 level are shown in Table 16. Of particular note are the two-way relationships between:

- (i) multiple user interests and multi-user communication problems
- (ii) multi-user interests and overoptimism among DSS developers
- (iii) lack of commitment to use DSS and lack of relevance of DSS project.

The ANOVA test used is a one-way test, so these two-way relationships are the results of pairs of tests. Each variable in a pair significantly relates to the levels of activity of the other.

### 6.6 Overall Implementation Problem Index

The average of a manager-developer's score for the nine implementation problems PR1 to PR9 is formulated as an Overall Implementation Problem (OIP) Index. This index is formulated as an aggregate measure of the impact of the implementation problems on DSS development.

Problem No.	Problem Description	Wilcoxon Results		Direction of Difference
		Z-Score	2-Tailed P	
1	Multi-User Commun. Problems	-2.994	.003	Smaller
2	Multiple Interests	-3.746	.000	Smaller
3	Overoptimism	-0.408	.683	Similar
4	Need for Additional CPU	-2.368	.018	Smaller
5	Computer Terminal Problems	-3.803	.000	Greater
6	DSS Language Problems	-3.598	.000	Greater
7	Project Not Relevant	-0.876	.381	Similar
8	Deadline Expiry	-2.175	.030	Smaller
9	Lack of Commitment to DSS	-0.314	.754	Similar

Table 17: Major Differences Between Individual Implementation Problems and Overall Implementation Problem Index.

## Statistical Results

Three implementation problems -- No. 3 (Overoptimism), No. 7 (Project not Relevant) and No. 9 (Lack of Commitment) are similar in score patterns to the OIP Index. Problem No. 5 (Computer Terminal Problems) and No. 6 (DSS Language Problems) show significantly greater scores than the OIP Index. The rest of the implementation problems have smaller scores than the OIP Index. This information offers a very interesting profile of the relative impact of implementation problems on DSS development in a manager-developer environment.

### 6.7 Other Implementation Factors Affecting DSS Development

Manager-developers are asked to identify additional implementation problems and factors, both positive and negative, which they believe affect their DSS development. One factor emerges as being present in most of the DSS projects deemed successful by their developers. This is the case of "validating the model." For a number of these successful DSS projects, manual solutions exist; the ability to match the results from DSS models with these previously obtained solutions gives developer-managers confidence in their modelling skills. A new implementation risk factor referred to as "difficulty of

model validation" is therefore presented as a result from this study, to be investigated by future researchers in this field.

## 6.8 Alter's Implementation Approaches and Strategies

### 6.8.1 Classification of Strategies

These implementation strategies are normally used to resolve implementation problems encountered in DSS development. Application of a strategy may have one or more consequences. It may successfully resolve the problem being tackled, and allow the manager to continue with his development. It may also fail to resolve the problem, in which case the manager can apply another strategy. A third outcome is also possible; application of a strategy may cause another implementation problem (which is not present earlier) to surface.

The Alter methodology identifies four basic implementation approaches; within each approach, several strategies are proposed. Of these strategies, ten are considered as appropriate for possible use in a manager-developed DSS environment. These are summarized in Table 18.

Results for the statistical tests used here are shown in Tables 19-21. Their implications are discussed below.

Implementation Approach		Implementation Strategy	
No.	<u>Description</u>	No.	<u>Description</u>
1	Divide the Project into Manageable Pieces	1	Use Prototype
		2	Evolutionary Model Approach
		3	Develop Series of Modelling Tools
2	Keep the Solution Simple	4	Keep the Model Simple
		5	Hide Complexity of Models
		6	Avoid Making Changes in Model
3	Meet User Needs and Institutionalize System	7	Tailor Model to Suit User
4	Develop a Satisfactory User Base	8	Get User Commitment
		9	Get User Participation
		10	"Sell the User"

Table 18: Relationship Between Implementation Approaches and Implementation Strategies in the Alter Methodology.

No.	SPSS Var. for Strategy	Abbreviated Description of Strategy	Freq. of Not Used Responses	Median Score	Chi-Square Values	Signif. Level	Null Hypothesis Status
1	DSSTRGY1	Use Prototypes	51.7	1.467	0.034	0.853	Supported
2	DSSTRGY2	Evolutionary Models	10.3	2.647	18.241	0.000	Rejected
3	DSSTRGY3	Develop Series of Modelling Tools	69.0	1.225	4.172	0.041	Rejected
4	DSSTRGY4	Keep Model Simple	6.9	2.694	21.552	0.000	Rejected
5	DSSTRGY5	Hide Complexity of Models	31.0	2.050	4.172	0.041	Rejected
6	DSSTRGY6	Avoid Making Changes in Model	31.0	1.958	4.172	0.041	Rejected
7	DSSTRGY7	Tailor Model to Suit User	13.6	2.308	15.207	0.000	Rejected
8	DSSTRGY8	Get User Commitment	3.4	2.920	25.138	0.000	Rejected
9	DSSTRGY9	Get User Participation	3.4	2.841	25.138	0.000	Rejected
10	DSSTRGY10	Need to Sell User	82.8	1.104	12.448	0.000	Rejected

Table 19: Hypothesis Testing for Implementation Strategies.



Implementation Strategy	1-Person Team Using Strategy		2-Person Team Using Strategy	
	No.	%	No.	%
1. Use Prototype	7	54%	4	50%
2. Evolutionary Modelling Approach	12	92%	8	100%
3. Develop Series of Modelling Tools	5	39%	2	25%
4. Keep the Model Simple	13	100%	7	87%
5. Hide Complexity of Models	10	77%	6	75%
6. Avoid Making Changes in Model	6	48%	7	87%
7. Tailor Model to Suit User	11	84%	8	100%
8. Get User Commitment	13	100%	8	100%
9. Get User Participation	12	92%	8	100%
10. "Sell" the User	2	16%	2	25%

Table 20: Strategy Use By Project Team Size.

KRUSKAL-WALLIS ANALYSIS OF VARIANCE			
Of Project Success By Implementation Strategy	Chi-Square Value	Significance Level	Null Hypothesis Status
1. Use Prototype	4.226	.121	Supported
2. Evolutionary Modelling Approach	0.168	.920	Supported
3. Develop Series of Modelling Tools	3.530	.171	Supported
4. Keep the Model Simple	2.985	.225	Supported
5. Hide Complexity of Models	0.074	.964	Supported
6. Avoid Making Changes in Model	2.282	.320	Supported
7. Tailor Model to Suit User	4.566	.102	Supported
8. Get User Commitment	0.311	.856	Supported
9. Get User Participation	5.566	.062	Supported
10. "Sell" the User	3.023	.221	Supported

Table 21: Significance of Relationship Between Levels of Project Success and Degree of Usage of Strategies.

## 6.9. DSS Implementation Strategies

### 6.9.1 Strategy 1: Use Prototypes

Just under half the manager-developers in the study make use of this strategy. In a number of DSS projects where this strategy is used, users external to the project team are involved. An inspection of the frequency statistics for use of this strategy according to team size shows no statistically significant difference between usage among 1-person and 2-person project teams. Of the thirteen 1-person teams in the study, six do not use this strategy, and seven do; of the eight 2-person teams, four do not use this strategy and four do. Level of DSS project success, as self-rated by manager-developers is not found to have a statistically significant relationship with the degree of use of this strategy.

### 6.9.2 Strategy 2: Evolutionary Models Approach

This strategy is used in twenty of the twenty-one DSS projects in this study. In two of the 2-person teams there is also a difference of opinion as to whether this strategy has been used. DSS project success is not found to have a significant

relationship with the use of this strategy. The general implications of the results for this strategy are that while this is a very popular strategy among manager-developers, its degree of use does not have a significant relationship with the level of project success achieved.

#### 6.9.3 Strategy 3: Develop Series of Modelling Tools

Over two-thirds of the manager-developers state that they do not use this strategy. Combining the results of the chi-square test with other descriptive statistics, the conclusion is that this strategy is not particularly likely to be used by manager-developers. No significant relationship is observed between level of project success and the degree of use of this strategy.

#### 6.9.4 Strategy 4: Keep Model Simple

This is a very popular approach to DSS development as more than ninety-three percent of the manager-developers state that they used this strategy. No significant relationship is observed between level of project success and the degree of use of this study.

#### 6.9.5 Strategy 5: Hide Complexity of Models

Approximately one-third of the manager-developers do not make use of this strategy. These are nearly all individuals developing DSS on their own. This relationship appears reasonable, since a person developing a model on his own for his own use does not need to be particularly concerned with this issue, generally aimed at increasing acceptance of a model by users who are not developers. From the results of the test for the null hypothesis for this strategy, the conclusion is that this strategy is more likely than not to be used. No statistically significant relationship is observed between level of project success and the degree of use of this strategy.

#### 6.9.6 Strategy 6: Avoid Making Changes in Model

This strategy is identified by Alter as a method of minimizing the user's resistance to change, for example by maintaining data inputs and output reports in forms used in the organization prior to introduction of the model.

Use of this strategy by developer-managers in situations where previously obtained solutions exist could result in validating

models through comparison of the two sets of results. In 2-person teams, use of this strategy could result in reduced DSS development time since changes made by one team member would not often conflict with those made by the other team member.

Over two-thirds of the manager-developers use this strategy, mainly from the 2-person teams. From the descriptive statistics for this strategy, the conclusion is that the degree of use of this strategy does not have a significant relationship with level of project success.

#### 6.9.7 Strategy 7: Tailor Model to Suit User

This strategy is very popular with manager-developers, with eleven of the thirteen 1-person teams and seven of the eight 2-person teams making use of it. No significant relationship is observed between the degree of use of this strategy and project success levels.

#### 6.9.8 Strategy 8: Get User Commitment

This strategy is used by 96.6 percent of the DSS manager-developers; since most are users of their models, this

percentage is not really as startling as it seems at first glance. No significant relationship is observed between the degree of use of this strategy and the level of project success.

#### 6.9.9 Strategy 9: Get User Participation

Usage statistics for this strategy are very similar to those for Strategy 8 (get user commitment), and requires a similar interpretation. No significant relationship is observed between the degree to which this strategy is used and the level of the project success reported.

#### 6.9.10 Strategy 10: Sell the User

Over four-fifths of the manager-developers indicate no need to "sell" their users on the DSS, for reasons similar to those for Strategies 8 and 9 for getting user commitment and participation. For this strategy as for the others discussed earlier, no significant relationship is observed between the degree to which this strategy is used and the level of the project success reported.

### 6.9.11 Application of Strategies 8, 9 and 10 in Parallel

Alter (1980, p. 173) notes that application of just one of these three strategies without consideration of the effects of the other two could lead to ineffective implementation.

Two DSS projects rated by their developers as low in success support Alter's observation. Project 11 on School Enrolment Population Forecasting is undertaken to assist school administrators. User participation (Strategy 9) has been at a medium to high level; users have provided input data for the model. User commitment (Strategy 8) is, however, low pending delivery of verifiable results from the model. Although the developer-manager does not perceive any need to "sell" the user (Strategy 10), the project "fizzles out" since the model results do not mirror the user's intuitive estimates of corresponding population forecasts.

Project 18 is undertaken to develop a model for budgeting education program hours and funds as a planning tool for school administrators (in another district). Here technical problems with the computer terminal and DSS language usage serve to disillusion a previously committed user (Strategy 8) to such an extent that the developer-manager has to really "sell" the user (Strategy 10) in staying involved with the project.



User participation (Strategy 9) declines rapidly when computer demonstrations of model execution have to be aborted due to technical problems.

#### 6.10 Relationship Between Implementation Problems and Implementation Strategies

From Table 22, the level to which additional computer resources are needed is seen to be related to the degree to which the strategies of "developing a series of tools", and "keep the model simple" are used. Application of a high level of the strategy of "developing a series of tools" serves to minimize the effect of the problem. Application of a medium level of the strategy "keep the model simple" appears to produce better results than using it at a high level. The relationship between OIP Index and the strategy of "Tailor Model to Suit User" is interesting since it suggests that one strategy could be used to cope with a broad spectrum of implementation problems. This strategy works effectively if applied either at a very low level (such as when the developer is also the user) or at a very high level (when external users are involved).

No.	KRUSKAL-WALLIS ANOVA TEST		Chi-Square Value	Significance Level
1	By	Need for Additional Computer Resources Develop Series of Tools	8.502	.014
2	By	Need for Additional Computer Resources Keep Model Simple	6.775	.034
3	By	Project Not Relevant Get User Commitment	8.120	.017
4	By	Overall Implementation Problem Index Tailor Model to Suit User	6.697	.035

Table 22: Significance of Relationship Between Levels of Impact of Implementation Problems and Degree of Strategy Usage.

### 6.11 Interrelationships Between Implementation Strategies

Table 23 shows the significant results of this test. An interesting perspective is gained of the interrelationships between these strategies by recording the Approaches under which they are categorized. Approach 1 (Divide the Project into Manageable Pieces) appears to have considerable interaction with the other Approaches. Table 23 offers useful prescriptive data on the effects of using any particular strategy on some other strategy. For example, the sixth result indicates that the degree to which a developer uses a strategy of "evolutionary model approach" will make a difference in the degree to which the strategy of "Tailor Model to Suit Users" is used. Besides No. 6, results 1 and 7 (when combined with descriptive statistics) identify pairs of strategies that can be applied in tandem at high levels. All the other results reflect one strategy being applied at a high level and the other at a low level. Often, the interaction is two-way, as seen from the second and fourth results.

### 6.12 Situational Variables: Statistical and Descriptive Analysis

		KRUSKAL-WALLIS ANOVA TEST	Approach No.	Chi-Square Value	Significance Level
1	By	Develop Series of Tools Hide Model Complexity	1 2	10.683	.005
2	By	Develop Series of Tools Avoid Making Changes in Model	1 2	13.660	.002
3	By	Hide Model Complexity Develop Series of Tools	2 1	8.025	.018
4	By	Avoid Making Changes in Model Develop Series of Tools	2 1	12.128	.002
5	By	Avoid Making Changes in Model Evolutionary Model Approach	2 1	6.379	.041
6	By	Tailor Model to Suit Users Evolutionary Model Approach	3 1	6.646	.036
7	By	Get User Participation User Prototypes	4 1	6.655	.036
8	By	Need to Sell the User Avoid Making Changes to Model	4 2	6.891	.032
9	By	Need to Sell the User Get User Participation	4 4	6.523	.038

Table 23: Interrelationship Between Levels of Implementation Strategies.

Description of Situational Variable	No. of "Not at all" Responses	Chi-Square Value	Significance Level
1. Degree of Sustained DSS Development	7	7.759	.005
2. Insight into Problem from Examining and Analyzing Input Data	8	5.828	.016
3. Transferability of DSS to Organization	2	21.552	.000
4. Cost Justification of DSS	6	9.966	.002
5. Insight into Problem from Modelling DSS	4	15.207	.000

Table 24: Significance of Situational Variables in DSS Development.

### 6.12.1 Statistical Significance Tests

In order to explore the nature of DSS development by managers-as-builders-and-users, managers are asked to rate the extent to which certain developmental variables are observed in their DSS projects.

As the results in Table 24 indicate, five such variables exceed the cut-off level for statistical significance of the null hypothesis that these variables are equally likely to be present as to be absent. Less than likely to be present (and therefore not observed) are sustained DSS development, insight into problem from data collection and examination, and transferability of a DSS to a manager's organization. A DSS development effort by a manager is more than likely to be cost justified and also to provide insight into the problem being modelled.

### 6.12.2 Overall Evaluation of DSS Project Success

Respondents are asked to rate the success of their DSS project efforts on a scale of 1.0 (not at all) to 5.0 (to a very great extent) using their own perception of the term "success" as a guide. The literature notes that implementation success is a composite variable, and that the signifi-

cance of the component dimensions is contingent on the specific situation in which implementation is undertaken.

For this sample, manager-developers identify through their comments that "success" is a composite of primarily two variables:

- (i) use of the DSS language, and
- (ii) solving the problems being modelled.

The frequency distribution of Overall Project Success shows a median score of 3.444, with 79.2 percent of the projects rated between successful "to a moderate extent" and "to a very great extent."

### 6.13 Relationship Between Implementation Strategies and Situational Variables

Table 25 shows the relationship between the levels at which a strategy is used and the levels at which a situational variable is present. For example, the first result may be interpreted to indicate that the need to keep the model simple varies according to the organizational function in which the DSS is used. From associated descriptive data, the conclusion

is that there is a greater need to keep the modelling simple for multi-function use of DSS than if the DSS is developed for a single organizational function. Most managers would intuitively agree with this conclusion, and not just for DSS development.

It is interesting to note the payoffs associated with using strategies aimed at gaining user confidence, commitment and participation. As results 3, 4, 5 and 6 show, cost justification of the DSS effort is made easier (traditionally a problem area for DSS projects), the effort proceeds in a direct manner as fewer changes are made in problem definition, and the developer gains additional insight into the user's problem. These results are not particularly startling when one remembers that the developer is also the user in the study environment.

#### 6.14 Relationship Between Implementation Problems and Situational Variables

As Table 26 indicates, three of the relationships between implementation problems and situational variables emerge as statistically significant. The problems associated with multi-user interests are greater for DSS developed for production functions than for any other management functions.



No.	KRUSKAL-WALLIS ANOVA TEST (S) = Strategy (A) = Situational Attribute		Chi-Square Value	Significance Level
1	By	Keep Model Simple (S) Org. Function in Which DSS Used (A)	12.330	.006
2	By	Hide Model Complexity (S) Decision Type Modelled (A)	6.009	.014
3	By	Changes Made in Problem Definition (A) Tailor Model to Suit User (S)	7.569	.023
4	By	Cost Justification of DSS Project (A) Tailor Model to Suit User (S)	10.576	.005
5	By	Insight into Problem from Modelling (A) Get User Commitment (S)	7.962	.019
6	By	Cost Justification of DSS Project (A) Get User Participation (S)	6.283	.043

Table 25: Relationship Between Implementation Strategies and Situational Variables.

Communication problems among users are greater for problems using shorter time horizons than for longer time horizons, i.e. there appears to be greater accommodation between users in dealing with the uncertainty associated with the future. Of particular interest is the greater overoptimism among DSS developers associated with data-oriented DSS than model-oriented DSS.

#### 6.15 Interrelationship Between Situational Variables

Table 27 indicates two related sets of situational variables. The transferability of a DSS project appears to become more difficult with longer time horizons modelled in the DSS. This may reflect difficulties in handling issues with greater uncertainties associated with the distant future. The second relationship seems fairly obvious, in that data collection for a DSS is much more difficult if it involves multiple organizational functions than a single unit.

#### 6.16 Other Areas of Exploratory Analysis

Responses from manager-developers are analyzed to determine the value of the DSS development experience, and to assess the

No.	KRUSKAL-WALLIS ANOVA TEST (S) = Strategy (P) = Problem (A) = Situational Attribute		Chi-Square Value	Significance Level
1	By	Multi-User Interests (P) Org. Function in Which DSS Used (A)	8.724	.033
2	By	Multi-User Communication Problems (P) Time Horizon Modelled in DSS (A)	4.354	.037
3	By	Overoptimism Among DSS Developers (A) Type of DSS (Data or Model Oriented) (P)	5.999	.014

Table 26: Relationship Between Implementation Problems and Situational Variables.

No.	KRUSKAL-WALLIS ANOVA TEST		Chi-Square Value	Significance Level
1	By	Transferability of DSS Project to Org. Time Horizon Modelled in DSS	6.009	.014
2	By	Difficulty in Collecting DSS Input Data Org. Function in Which DSS Used	12.330	.006

Table 27: Interrelationship Between Situational Variables.

consequence of this experience in terms of their views on possible future use of the DSS approach to problem solving.

Since DSS is offered as a facility to support managerial judgment, its value may be assessed through the insight a manager gains into his problem.

#### 6.16.1 Insights into Problem from Modelling

Insight derived by model developers into the problems being modelled is frequently mentioned in the management science literature as a primary benefit from the modelling exercise. In this study, respondents are asked to comment on the types of insight gained through their DSS development. The first example is taken from Project No. 2, A Company in Insolvency. Mr. CC is retained by a bank to examine the financial health of a company to which the bank has made loans. Mr. CC notes that "as an outside observer of the company, I could not begin to understand all of the interrelationships. Despite these limitations, the models produced additional information in a form and manner so that the bank and the company could make better decisions." By performing a variety of sensitivity analyses, it is determined that the bank's security would be only marginally affected by changes in interest rates. However, if the company is unable to meet its sales and profit

margin goals, the bank would be forced to appoint a receiver-manager to recover its security. There are two aspects to the insights gained into this problem. As to the model development process, Mr. CC credits the need to state interrelationships explicitly in the model as a strong reason for his examination of specific areas of company operation. Similarly, the requirements for input data for the model serves to identify areas in the company where the record-keeping has to be considerably improved.

A different type of insight is gained in Project No. 4, Corporate Budgeting Model for a retail "home centre" operation. The model incorporates a number of heuristics on corporate ratios and so closely parallels the budgeting process of the developer, an executive of this firm. One of the benefits from the modelling exercise is that this individual is able to derive ratios between other pairs of key variables to add to his considerable arsenal of performance heuristics.

In Project 5, A New Product Introduction, Mr. I comments:  
"the capabilities of the DSS language allowed me to consider analytical options that I would not have normally considered. Actually using these options provided considerable insight into the problem."

Another form of insight pertains to increased confidence in using a tool such as DSS. In Project No. 7, Real Estate Investment Analysis, Mr. K notes, "my prior exposure to computers was limited. I purposely took on a problem I thought I could handle."

For Mr. L in Project No. 8, Staffing of Customer Service Functions, the insight comes from modelling an alternative method of staffing which is intuitively more costly; he finds that although the costs are incurred at a different time, the total remains unchanged. His comment: "Enlightening!"

Ms. M, a developer of Project No. 9, Manpower Planning, undertakes her project fully expecting to show that her office is understaffed. When the model results indicate that her office is actually overstaffed, she probes deeper into the assumptions on which her staffing levels are determined by headquarters. Much to her surprise, she discovers that staffing levels are based on standards for work components for which her office is not required to (and does not) maintain any records.

Ms. Q, a developer of Project 12, a Merchandise Budgeting model, comments that the insights derived from modelling "could lead to procedural changes in the budgeting system." For Mr. T, in Project 14, the insight gained allows him to develop a

basis "for extending the budget process into a 3-5 year strategic plan." In Project 17, the emphasis suggested by the model is exactly opposite to the normal corporate practice.

The variety of ways in which insight is gained is clearly demonstrated by the above examples, and attests to the value of the DSS approach to manager-developers. Insight is gained not just as increased understanding of unfamiliar situations, but in seeing familiar situations in a different light.

#### 6.16.2 Future Use of DSS

Respondents are asked to identify the extent to which they would use the DSS approach for solving problems if it is an appropriate methodology. This question is posed to determine their overall assessment of the DSS approach to solving managerial problems. Eighty-six percent of the managers respond favourably to this question. The favourable responses shown in Table 28 below are qualified in that managers are asked to assume that DSS would be adequately supported for use in terms not only of hardware and software, but for technical assistance in model building as well.

Category of Response	Abs. Freq.	Relative Freq.
Not at All	3	10.3
To a Small Extent	1	3.4
To a Moderate Extent	7	24.1
To a Great Extent	10	34.5
To a Very Great Extent	8	27.6
Total	29	100

Table 28: Management Responses for Future Use of DSS Approach.



### 6.17 Summary

This chapter presents the results from investigating manager-developed DSS. Manager-developers appear to favour development of suggestion models aimed at computerizing routine decisions, and to avoid models featuring optimization techniques. Implementation problems associated with computer usage and DSS language are considered very significant.

These two implementation problems rank higher than the group representing overoptimism of developers and lack of commitment or project relevance, which in turn rank higher than the group representing problems related to multiple users, need for additional computer or project development time. Taken together, they present a useful profile of the significance of implementation problems. "Difficulty of model validation" emerges as a candidate for an additional implementation risk factor in the manager-developed DSS environment.

Implementation strategies other than "use prototypes" and "develop series of modelling tools" are more likely than not to be used in the study environment. The two exceptions are usually aimed at gaining user commitment and participation, an issue of minor importance when the DSS developer is also the user. Interestingly, no significant relationships are

observed between levels of project success and levels to which these strategies are used.

Managers perceive that their development efforts can be easily cost justified through the insights gained into their problems being modelled. Management of DSS efforts aimed at single organizational functions are not necessarily less difficult than for multi-function applications. Overoptimism among developers is greater for data-based DSS than for model-based DSS, but both groups express a high likelihood of using a DSS approach in future.

Finally, all of Alter's implementation problems (and therefore risk factors) and implementation strategies are relevant in the manager-developed DSS environment, but problems and strategies related to users are less relevant than the others.

CHAPTER VII: SUMMARY, CONCLUSIONS, IMPLICATIONS AND  
RECOMMENDATIONS

7.1 Introduction

In this concluding chapter of the study, the research problem, objectives and methodology are summarized to give an overview of the total exercise. Results reported in Chapters V and VI are interpreted as conclusions, and their implications are noted. The limitations of the study are identified, and in the last section of this chapter, recommendations are made for further research on decision support systems as developed by managers.

7.2 Summary of Research Study

7.2.1 The Study Problem

A decision support system (DSS) is defined in this study as an interactive computing system supporting the decision processes

of managers with flexible access to models and relevant input information. This study is an exploratory investigation of DSS developed by managers for their own and other managerial use. It tests a number of hypotheses arising from Alter's implementation risk analysis methodology. Current levels of usage and acceptance of computer-based decision systems (CBDS) in respondent organizations are analyzed, and compared against managerial perceptions of what should be done in this area.

#### 7.2.2 Purpose and Significance of Study

To date, most computer-based decision systems in use have been designed by technical specialists for use by managers. A variety of situational factors encompassing organizational, managerial and system characteristics have been proposed by researchers to explain the unsuccessful and successful development of these systems. Alter has identified a set of implementation problems and offsetting implementation strategies that apply to the development of decision support systems.

The purpose of this study is to investigate the extent to which this set of implementation problems, implementation strategies and situational variables affect the development of DSS when managers are developers as well as users of these systems.

This study makes an original and interesting contribution to the literature in the area of manager-developed DSS, where research data is scarce. It does so by developing a profile of the significant relationships between implementation problems, strategies and situational variables which managers encounter when building a DSS. These variables can be used in a diagnostic or a prescriptive mode.

### 7.2.3 Areas of Concern in the Study

Two sets of questions are raised in this study. The first set, discussed in Chapter V, concerns the level of organizational usage and acceptance of computer-based decision systems (CBDS). The significance of the issues are examined and analyzed under three states: in the present state (AS IS), in an idealized state (SHOULD BE) and in a state which assumes a DSS facility is implemented and adequately supported in an organization (IF DSS USED). Differences in levels of response scores between these three states are formulated as perceived gaps between pairs of states. Relationships of the AS IS state and the two corresponding perceived gaps are tested for significance against a number of situational variables representing organizational and managerial characteristics.

The second set of questions are discussed in Chapter VI and pertain to the experiences of managers who have built and used their DSS. Alter's methodology identifies a number of implementation factors and related problems which pose possible risks to the successful implementation of DSS, mainly in situations where the system developers are different from system users. A number of implementation strategies to offset the impact of these problems have also been proposed by Alter. The issues raised in this study relate to the likelihood of these implementation problems being encountered and the implementation strategies being used in manager-developed DSS. Relationships between implementation problems, implementation strategies and situational variables representing DSS characteristics are also examined for statistical significance to obtain additional exploratory research information.

#### 7.2.4 The Study Procedure

##### Data Collection

Data for this study are derived as coded responses to a four-part questionnaire, from free-form written comments and from personal interviews. Managers whose DSS development experience is examined in this study participate in each of

the above methods of data-assembly. A second group of managers provide data for two parts of the questionnaire, focussing on the use of and attitudes towards computer-based decision systems in their organizations. All participants are identified by code numbers to guarantee confidentiality of response. Questionnaires are pretested for clarity of wording and meaning of questions, and post-tested to verify that coded responses are in agreement with written comments. Personal interviews are conducted with the manager-developers of twenty-one DSS. Comments made by them are used to complete Questionnaire Section 6 and to develop a write-up for each DSS and its development process. Questionnaire data is then coded for keypunching, and used as input to the SPSS (Statistical Package for the Social Sciences) program.

### Major Variables of Study

The major variables which are analyzed in this study can be categorized into four types. The first type includes the attitudes and perceptions of the responding managers towards computer-based decision systems (CBDS) as these systems exist in their organizations, as they should exist (in a desired sense), and as they would if decision support systems were technically supported for use. The second type corresponds to implementation problems as identified by Alter in his

methodology, and implementation strategies proposed to offset these problems. The third type corresponds to the situational variables made up of managerial and organizational characteristics appropriate to the responding managers. Finally, the fourth type of variables in this study represent the characteristics of the DSS development process. Variables which are aimed at measuring perception, attitude or opinion are input on a five-point Likert scale.

### Statistical Tests

No assumptions are made in this exploratory study as to the nature of the population from which the sample of managers is drawn. The resulting use of nonparametric techniques produces conclusions which require fewer qualifications than for their parametric counterparts. Four types of tests are used in this study. The first is the one-sample chi-square test and is used to determine whether a single sample (one SPSS variable) is from a specified sort of population. The second is the Wilcoxon matched-pairs signed ranks test, and is used to compare the responses yielded by two related samples (e.g. two SPSS variables such as for AS IS and SHOULD BE Queries for the same Statement). The third is the Kruskal-Wallis One-way Analysis of Variance by Ranks test, and is used for deciding whether the differences among responses to a variable signify



genuine population differences when analyzed by K levels of another variable. The fourth type of test is a joint frequency distribution of two or more variables. A significance level of .05 is used as a cut-off for all these tests. In addition to these statistical tests, one-way frequency distribution statistics are computed for a number of variables.

### Presentation of Results

The results presented in this study are a combination of descriptive and statistical analysis. The former is developed mainly from the comments made by responding managers in questionnaires or at interviews, and the latter as summaries of the results of the nonparametric tests undertaken in this study.

## 7.3 Summary of Results

### 7.3.1 Factors Concerning Usage and Acceptance of Computer-based Decision Systems (CBDS)

Respondents to the questionnaire survey are asked to examine ten Statements relating to the use and acceptance of computer-

based decision systems (CBDS) in their organizations. Each Statement is queried for significance under three scenarios: AS IS (the present state), SHOULD BE (the desired state) and IF DSS USED (a state in which a particular type of CBDS, a DSS, is supported for use).

#### Results for the AS IS Query

The overall results may be interpreted as a less than enthusiastic acceptance of CBDS by respondent organizations at the present time. As an explanation of these results, it is noted that the literature survey indicates a positive correlation between top management support and successful development and implementation of CBDS. Absence of such support would be indicated by a neutral or low score for this variable; this score for top management support is then consistent with the neutral or low response levels for most of the other Statements on CBDS use.

#### Results for SHOULD BE Query

Managers are in general agreement that the activities represented by each of the ten Statements should take on added significance in their organizations, i.e. they indicate a supportive attitude to the future acceptance and use of CBDS.

Results for IF DSS USED Query

Managers who have developed the DSS examined in this study are asked to consider the implications of the availability in their organizations of a specific form of CBDS, namely DSS. The responses obtained here indicate that while managers are favourably disposed towards DSS, they also reflect an uncertainty regarding use of support services, either from technical analysts or from consultants.

Perceived Gaps between AS IS, SHOULD BE and  
IF DSS USED Queries

A "perceived gap" is assumed to exist between any two Queries for a Statement if there is a statistically significant difference between the two scores. In this study, gaps are perceived to exist for all comparisons between the AS IS and SHOULD BE Queries; scores are higher for the SHOULD BE state, and are indicative of a desire among respondent managers for greater activity in CBDS in their organizations.

Gaps are perceived to exist in several areas in comparing AS IS with IF DSS USED Query responses. Several inferences can be drawn from these results. First, greater management support is anticipated for the use and acceptance of DSS than

is the case at present with CBDS. Second, there would be more frequent use of DSS than is now with CBDS. Third, managers would be more effective in the use of DSS than they are now with CBDS. Fourth, DSS would be more attuned than CBDS to specific decision making requirements. Fifth, managers perceive fewer technical barriers to the use of DSS than with CBDS. As well, the respondents indicate that they would use DSS more than they do now with CBDS. Taken as a whole, these results reflect a managerial perception that DSS, if available and supported in organizations, would be used and accepted by managers to a greater extent than CBDS are at present.

No gaps are perceived to exist between the SHOULD BE and IF DSS USED Queries over the majority of the Statements. The absence of a gap suggests that a DSS may be a possible vehicle to reach the SHOULD BE state from the AS IS state for that particular issue. Gaps are perceived to exist in the level of managerial input to organizational decision making and the degree to which explicit use of environmental factors is made as an input to decision-making. A likely interpretation of these two results is that while respondents perceive that more should be done in these areas, this will not be done just because a DSS is made available and supported for use.

Results on the Significance of Situational Variables

A total of nineteen situational variables representing managerial and organizational characteristics are analyzed for significance of relationship with the various Statements.

For the AS IS Query, the results reflect the present status of CBDS in respondent organizations, and suggest a variety of relationships; these relationships should not be interpreted as being causal in nature, but rather as correlations.

Significant relationships include the following:

- (a) A greater level of management support correlates with increased level of technical and user support for CBDS. This relationship supports the findings of the literature survey that both factors are important to the successful implementation of DSS.
  
- (b) A greater use of consultants on CBDS correlates with lower levels (as compared to moderate and high levels) of competition faced by an organization. A plausible explanation is that CBDS are not presently viewed by managers as tools which give organizations a competitive edge in their normal operations.

- (c) A greater level of managerial effectiveness with CBDS and frequency of CBDS use correlates with an increased level of organizational support of CBDS. This relationship reflects a positive managerial response to using a well-supported service, and is similar to (a) in its orientation.
  
- (d) A greater level of CBDS use for specific decision-making requirements correlates with an increased level of organizational support for CBDS. This relationship indicates a positive result for managers from using a well-supported CBDS facility.
  
- (e) The level of personal use of CBDS by respondents increases with their level of knowledge regarding CBDS, their overall attitude towards CBDS and the level of organizational support available for DSS. These relationships identify specific attributes which could lead to the adoption of CBDS by managers as a personal tool.
  
- (f) In comparison with managers with no DSS background, managers with DSS development experience perceive significantly lower levels of top management support for CBDS. They report lower use of CBDS and related consulting services in their organizations.

A possible explanation for these relationships is that the DSS experience gained by managers also raises their expectations on its productive use in their organization. If top management support does not match these expectations, the perceptions noted here may follow as a consequence.

These relationships can be used in a prescriptive or a diagnostic mode with respect to the status of CBDS in an organization. In using result (a) in a prescriptive mode for example, gaining management support would appear to be required before technical or user support for CBDS could be increased.

#### Significance of Relationships between Perceived Gaps and Situational Variables

The perceived gaps between AS IS and the other two Queries are analyzed to determine if changes in responses to Statements are significantly different for varying scores for situational variables.

#### Perceived Gaps between AS IS and SHOULD BE Queries

Several relationships between perceived gaps and situational variables are found to be statistically significant, and

suggest the following conclusions:

- (a) A greater amount of judgmental input to organizational decision-making is desired by managers with a lower knowledge level of CBDS than by those with a higher knowledge level of CBDS.
- (b) Female managers perceive a need for a greater degree of judgmental input to managerial decision-making than their male counterparts.
- (c) Explicit use of environmental factors in decision-making is desired to a greater extent by managers with a little (under two years) experience than those with greater experience in their present position.
- (d) Female managers perceive a need for more frequent use of CBDS than their male counterparts.
- (e) Managers whose workplace is a branch office perceive a need for greater increase in managerial effectiveness with CBDS than those employed in head offices.
- (f) Female managers perceive the need for a greater degree of reduction in technical barriers to the use of CBDS than their male counterparts.



- (g) The increase needed in the amount of personal use of CBDS by a manager is perceived to be greater by female managers than male managers; it varies according to the field in which managers achieved their highest educational level prior to MBA enrolment (it is lowest for engineering and technology graduates), and it is perceived to be greater in organizations with lower levels of CBDS support.
- (h) In comparison with managers with no DSS background, managers with DSS development experience perceive a greater need for increased management support of CBDS activities, and a need for greater delegation of associated quantitative analysis to technical analysts.

These conclusions are reasonable if viewed from the perspective of managerial experience. Individuals with greater managerial experience often acquire an overall appreciation of their environment which permits them to operate satisfactorily even in the absence of quantitative data such as those available from CBDS. Newer managers or managers at lower levels are more likely to require the support of "hard" data such as from CBDS for their organizational decision-making activities. This support is more likely to be available in a centralized facility such as a head-office rather than a branch office.

The conclusions relating to female managers are also explained by noting that these respondents in the study sample are relatively new to management and occupy positions in the lower and middle management levels. The rationale developed above, to explain the conclusions for newer and junior managers, are also applicable to female managers.

#### Perceived Gaps between AS IS and IF DSS USED Queries

Differences in responses to Statements for these two types of Queries are analyzed for significance of relationship with varying levels of situational variables.

If DSS are supported for use in organizations, the following outcomes are suggested:

- (a) The level of management support for CBDS activities will increase by a greater degree in the perception of female (as compared with male) managers.
- (b) The increase in management support for CBDS activities will vary when analyzed by the field in which respondents achieve their highest level of educational qualification; the increase is perceived to be highest by respondents from the Business Administration field.

- (c) The frequency of use of CBDS will increase by a greater degree in the perception of female managers than for male managers and also when a branch office is the workplace rather than a head office.
  
- (d) Managerial effectiveness will increase by a greater degree in the perception of female managers, also when the workplace is a branch office or if the type of organizational work function is of a "line management" type.
  
- (e) The extent to which CBDS is tuned to specific managerial decision-making requirements will vary according to the particular field of education in which highest level of qualification is attained (highest for Education and Business Administration), the type of organizational workplace (highest for branch office), the type of organizational work function (highest for line management) and length of managerial experience (increases with length of time in the same position).
  
- (f) The amount of personal use of CBDS will increase by a greater degree in respondent organizations encountering lower levels of time pressures, also if the workplace is a branch office.

- (g) Situational variables displaying a significant relationship with this perceived gap in an overall sense are the respondent's sex (highest for female), field of education in which highest level of qualification is obtained (highest for Business Administration), the type of workplace (highest for branch office) and work function (highest for line management).

These conclusions and relationships noted above reflect the experiences of managers who are DSS developers. Taken as a whole, they imply a favourable attitude towards DSS as a personal managerial tool; this will be aided by a movement of DSS usage from head offices to branch offices and from staff management functions to line management.

### 7.3.2 General Conclusions on Manager-Developed DSS

Manager-developers successfully categorize their DSS projects within the Alter taxonomy. Two significant differences between the present study and two other studies of the validity of Alter taxonomy (Grindlay et al, 1981 and Alter, 1979) are the absence of any optimization models and a preponderance of suggestion models. Since suggestion models generally involve a mechanization of structured tasks previously executed on a manual basis i.e. normally a time-

consuming task, it is not surprising that managers-developers have concentrated as a group on developing this category of models as a personal decision support tool. This explanation is reinforced by the statistic that three out of four DSS are aimed at routine decisions. The financial management function accounts for the largest group (37.9 percent) of DSS followed by multi-function DSS applications for another 31.0 percent. Over half of the DSS reflect a time horizon of one year.

### 7.3.3 Implementation Problems in Manager-Developed DSS

One research objective is to determine the likelihood of any implementation problem previously identified by Alter appearing in the study sample. Two implementation problems are more prone to occur in manager-developed DSS. They are:

- (a) technical problems with computer usage
- (b) mistakes which occur due to unfamiliarity with specifications of a DSS language.

For two other implementation problems:

- (a) multiple users or implementors causing communication problems

(b) multiple users or implementors leading to an inability to incorporate multiplicity of interests,

there is a significant difference in response scores when analyzed by team size. These problems are associated to a greater degree with DSS developed by teams in pairs than by individual managers.

Another research objective is to investigate the effect of one implementation problem on another implementation problem. Of particular note in this context are the interactions observed between:

(a) multiple user interests vs. multiple user communication problems

(b) multiple user interests vs. overoptimism among DSS developers

(c) lack of commitment to use DSS vs. lack of relevance of DSS project.

These results can be used in a diagnostic or a prescriptive mode. For each result, the factors operate in tandem, i.e., an increase in the level of one factor is associated with an increase in the level of the other. Knowledge about one

factor thus permits diagnostics or predictions to be made about the state of the other factor.

A third research objective is to observe the relative significance of these implementation problems in a manager-developed DSS environment. An overall implementation problem (OIP) index is formulated from the average score of all the implementation problems examined, and the score for each implementation problem then matched against the OIP Index. Problem No. 5 (Computer Terminal Problems) and Problem No. 6 (DSS Language Problems) have significantly greater scores than the OIP Index. Three implementation problems -- No. 3 (Overoptimism among system developers or users), No. 7 (Project Not Relevant) and No. 9 (Lack of Commitment) are similar in score patterns to the OIP Index. Problem No. 1 (Multiple User Communication Problems), Problem No. 2 (Multiple User Interest), Problem No. 4 (Need for Additional Computer Resources) and Problem No. 8 (Project Deadline Expiry) have significantly smaller scores than the OIP Index.

This profile of the relative significance of these implementation problems can be used in assessing the status of a current DSS development or in planning for a future effort. The issue of gaining user participation, commitment and support has been highlighted in the literature as an area deserving careful attention when the objective is one of

ensuring successful system development and implementation. It is interesting to note that in a manager-developed DSS environment, these user-related concerns are far less significant than the technical issues of working with computer terminals and DSS languages.

A fourth research objective is to determine if any other implementation risk factors (beyond those identified by Alter) are observed in a manager-developed DSS environment. This study identifies "the difficulty of model validation" as another implementation risk factor which affects DSS development when managers are developers and users of their DSS.

This completes the presentation of conclusions pertaining to implementation problems and risk factors. Next, the conclusions pertaining to offsetting implementation strategies are summarized.

#### 7.3.4 Implementation Strategies Used in Manager-Developed DSS

One research objective in this area is to determine the likelihood of use of each of the Alter implementation strategies. The use of Strategy 1 (Use Prototypes) and



Strategy 3 (Develop Series of Modelling Tools) is not statistically significant in a manager-developed DSS environment. Since the intent of these strategies is to gain user commitment and participation, a likely explanation is that their use is not quite as important when the manager is the developer as well as the user of a DSS. The other strategies are more likely than not to be used in a manager-developed DSS environment.

A second research objective is to determine the existence of any relationship between the successful development of a DSS and the strategies used in the process of that development. No significant differences are observed in the levels of project success which can be explained by differences in the levels to which these strategies are used.

A third research objective is to test Alter's observation that the application of just one of Strategies 8, 9, and 10 i.e., "Gain User Commitment", "Gain User Participation" and "Sell the User" without consideration of the other two could lead to ineffective implementation. Two projects rated by their developers as low in success fit Alter's observed pattern; one project has a low usage of Strategy 8 (Gain User Commitment) and the other of Strategy 9 (Gain User Participation). These patterns thus lend support to Alter's assertions.

A fourth research objective in this area is to examine the effect of using one implementation strategy on the use of any other implementation strategy. An interaction is noted between the strategies of "Develop Series of Tools" vs. "Hide Model Complexity". A reasonable interpretation is that the development of a series of tools is a necessary pre-requisite to hiding model complexity in logic and in output; the tools themselves, however, cannot be very complex in logic since otherwise there would be no benefit in developing them as separate entities.

There are significant differences in the degree to which the strategy of "Avoid Making Changes in Model" is used when analyzed by the levels at which two other strategies, "Develop Series of Tools" and "Evolutionary Modelling Approach" are used. In the first relationship, the "changes" are made in the series of tools so as to avoid making them in the model. In the second relationship, the significance of the changes in the model are minimized by adopting a gradual process of evolution. A third relationship arises from the use of the strategy of avoiding changes in the model as a means of "Selling the User", i.e. to gain user confidence and increased commitment and participation.

### 7.3.5 Interaction between Implementation Problems and Strategies

In this study, an implementation strategy is used to avoid or resolve a problem. The level to which additional computer resources are needed (a problem) is seen to be related to the degree to which the strategies of "Developing a Series of Tools", and "Keep the Model Simple" are used. The one strategy of "Tailor Model to Suit User" appears useful in coping with a broad spectrum of implementation problems when external users are involved.

In addition to directly analyzing the relationships between implementation problems and strategies, a third set of variables representing DSS development characteristics is considered for analysis. The statistical significance of these DSS development variables and their relationship with implementation problems and strategies are summarized below.

### 7.3.6 Significance of DSS Development Variables

Two interesting results in this area are the high degree to which managers perceive they can justify costs (mainly their own time) associated with DSS development, and the degree of insight gained into their problem from either the modelling

exercise or through collection and analysis of the input data for their DSS project. Taken together, these results suggest that manager-developers perceive their DSS projects are a useful investment of their time and effort.

A second area of investigation concerns the relationship between implementation strategies and DSS development variables. Here it, appears that although user oriented strategies do not enjoy statistical significance on their own, they are nevertheless positively correlated with two critical aspects of DSS development, namely cost justification of effort, and gaining insight into problems being modelled.

A third area of investigation is the relationship between implementation problems and DSS development variables. Here, the difference in levels at which multiple user interests are present are higher for multi-function projects than projects aimed at a single management function.

DSS development variables, i.e. the various DSS project attributes, are also examined for significance of relationship amongst each other. The level of difficulty in collecting and analyzing input data varies with the organizational function in which the DSS is to be used, and is highest for multi-function usage. This is an acceptable conclusion because of

the number of possible sources of input data, and difficulties in collecting data may arise in any of these areas.

### 7.3.7 Other Areas of Exploratory Research

As the issue of problem insight appears to be of some significance to manager-developers, their comments are examined to determine the ways in which insight into problems are gained. It appears that insight is gained through an increased understanding of unfamiliar situations as well as in seeing familiar situations in a new way.

On the basis of what is essentially their first experience in DSS development, manager-developers assess the likelihood of their using a DSS approach to problem-solving in the future. Over eighty-six percent of the respondent scores indicate a "moderate" to a "very great" likelihood of using a DSS approach, assuming organizational support and technical assistance exist at an adequate level.

The overall research study conclusion is one of optimism, i.e., that manager-developed DSS will prove to be a useful problem-solving tool. The implementation risk factors and implementation strategies identified in the Alter methodology are all found to be relevant in the development of DSS where

managers are builders as well as users. However, some factors and strategies are less relevant than others.

#### 7.4 Limitations of the Study

- (a) This study is exploratory in nature in its investigation of a relatively new phenomenon of managers who develop decision support systems for their own and other managerial use.
- (b) It is limited to an analysis of data obtained from managers enrolled in an Executive MBA program during the Spring of 1982. While the study results support a large number of the research hypotheses, there is no attempt to generalize the conclusions of this study to any other population.
- (c) The sample size of managers surveyed in this study is small by conventional standards in survey-oriented research. Nevertheless, it is not an unusual situation in studies of an exploratory nature, such as the one undertaken here.
- (d) The types of DSS examined in this study are a subset of those reported in the literature. They do not include

access to any large data bases, so data management problems are not a major factor in the development process of these DSS.

- (e) Although the DSS examined here are developed to the stage where useful results are obtained by managers in a majority of the projects, they cannot be considered to be implemented in an organizational context.
- (f) A number of factors are held constant in this study. These include the DSS language used for development, the amount of instruction in the use of the DSS language, and the imposition of a common deadline for the conclusion of DSS project development efforts.
- (g) The respondent managers who experience difficulties during DSS development persist until the deadline, since their grades for a university course are at stake. No claims can be made that they would continue with their DSS development efforts in the absence of such a penalty as failure in a course.
- (h) Finally, there is a key assumption which permeates throughout the entire study. It is that the responses of the managers participating in this study regarding DSS development are an accurate representation of their

perceptions, attitudes and experiences. This fundamental assumption is considered to be a reasonable one, given the makeup of the present sample.

### 7.5 Recommendations for Future Research

A purpose in undertaking exploratory research is to open new paths for future researchers to follow. This particular study is no exception in this regard. It has identified a number of variables encompassing implementation problems and strategies, and attributes of organizational, managerial and project characteristics which significantly affect the DSS development process. It has further determined that differences in response scores for a number of these variables show statistical significance when analyzed by levels of other variables.

Further research is recommended to expand knowledge in each of the above areas. Specific recommendations include the following:

- (1) Monitor the usage and acceptance of CBDS (including DSS) in organizations;
  - (a) Generalize the perceptions obtained from the AS IS, SHOULD BE and IF DSS USED Queries to a larger



population of managers. As the number of manager-developers of DSS continues to grow, this can be achieved by expanding the research program to allow larger samples from other provinces, industries and universities.

(b) Conduct research to measure periodic changes in perceptions regarding AS IS, SHOULD BE and IF DSS USED Queries and "perceived gaps".

(c) Conduct research into why managers perceive that differences exist in certain categories of variables.

(2) Research on manager-developed projects;

(a) Conduct longitudinal studies on manager-developed DSS from the design stage onwards for a sufficient period of time to observe and analyze implementation patterns or, alternately for unsuccessful projects, to focus on project abandonment decisions.

(b) Conduct further analyses into managerial perception of what is regarded as a "successful" DSS development, when they are the developers as well as users. Disaggregation of the "success" variable

into logical components offers an area for research into examining relationships with other variables affecting DSS development.

(c) Allow factors held constant in this study, such as computer system used, project deadline, DSS language instruction, etc. to vary in controlled experiments.

(d) Conduct research into managerial perceptions of the particular implementation risk factor identified in this study as "difficulty of model validation", evaluate its manifestation as implementation problems of various types, and analyze the significance of its relationships with other implementation problems, strategies, situational variables and DSS project characteristics.

(3) Field studies and controlled laboratory experiments;

(a) How is the process of development of DSS by managers affected by a change in their decision-making environment? Changes in a manager's position, organization or type of computer support are possible examples.

- (b) Do these changes affect all developer-managers in a similar fashion? Can differences be related to organizational, managerial or project characteristics?
- (c) Do the factors identified as significant in this study apply for manager-developed DSS in different environments such as other provinces, industries or universities?
- (d) What differences exist between a manager-developer's perception of the DSS development process (as measured through questionnaires or interviews) and the actual situation (from observation or monitoring computer usage records)?
- (e) How can the gap between any such differences be closed?

In summary, this research study provides a firm foundation for a variety of future research projects into the innovative area of manager-developed decision-support systems.

APPENDIX 1

Copy of Questionnaire Sections 1-6  
including letters of transmittal.

Section 1	Completed by all managers.
Section 2	Completed only by managers who did not develop DDS examined in this study.
Sections 3-6	Completed only by managers who did develop DSS examined in this study.

September, 1982

To Respondents of  
Questionnaire Section 1 for Research Study on  
Managerial Use of Computer-Based Decision Systems

Thank you for participating in this research study by offering your views and perceptions on a number of issues regarding managerial use of computer-based decision systems, often referred to as decision support systems.

The questionnaires which have been developed to collect this information ask for your attitude towards and experience with computer-based information systems, and background information about the organizational environment in which you work.

The questionnaire has been assigned a code number to maintain confidentiality of your responses. Only the researcher will be aware of your identity.

It should take no more than ten minutes of your time to complete the section. You can help by returning the completed questionnaire at your earliest convenience to any one of the following:

- 1) Ronnie Brumec at the MBA office (or at dinners at SFU).
- 2) My mail slot in the General Office (AQ 5100).
- 3) Mail it to me at B.C.I.T.:

D.K. Chowdhury  
Marketing Management Department  
B.C.I.T.  
3700 Willingdon Avenue  
Burnaby, B.C.  
V5G 3H2

I expect to present the results of my study to your class at the earliest convenient opportunity. I regard this as a very interesting subject for research, and I hope you do, too.

Thank you for your cooperation.

Yours truly,

D.K. Chowdhury

Code No. \_\_\_\_\_  
(To maintain  
confidentiality)

Section 1: Instructions

These questions pertain to your experience in business and with computer-based decision systems. Please put an X in the blank space that most closely approximates your answer.

1. To what extent did your pre-MBA experience and training provide you with knowledge about computer-based decision systems?

Not at all \_\_\_\_\_ ;  
To a Very Small Extent \_\_\_\_\_ ;  
To a Moderate Extent \_\_\_\_\_ ;  
To a Great Extent \_\_\_\_\_ ;  
To a Very Great Extent \_\_\_\_\_ ;

2. To what extent does your present experience and training provide you with knowledge about computer-based decision systems?

Not at all \_\_\_\_\_ ;  
To a Very Small Extent \_\_\_\_\_ ;  
To a Moderate Extent \_\_\_\_\_ ;  
To a Great Extent \_\_\_\_\_ ;  
To a Very Great Extent \_\_\_\_\_ ;

3. To what extent does your organization provide you with knowledge about computer-based decision systems?

Not at all \_\_\_\_\_ ;  
To a Very Small Extent \_\_\_\_\_ ;  
To a Moderate Extent \_\_\_\_\_ ;  
To a Great Extent \_\_\_\_\_ ;  
To a Very Great Extent \_\_\_\_\_ ;

4. How would you rate your overall attitude when working with computer-based decision systems?

- Very Negative                    \_\_\_ ;
- Negative                        \_\_\_ ;
- Indifferent                    \_\_\_ ;
- Positive                        \_\_\_ ;
- Very Positive                  \_\_\_ ;

5. To what extent is your organizational environment characterized by stability?

- Not at all                      \_\_\_ ;
- To a Very Small Extent        \_\_\_ ;
- To a Moderate Extent         \_\_\_ ;
- To a Great Extent             \_\_\_ ;
- To a Very Great Extent       \_\_\_ ;

6. To what extent is your organizational environment characterized by competition with other firms?

- Not at all                      \_\_\_ ;
- To a Very Small Extent        \_\_\_ ;
- To a Moderate Extent         \_\_\_ ;
- To a Great Extent             \_\_\_ ;
- To a Very Great Extent       \_\_\_ ;

7. To what extent is your organizational environment characterized by time pressures?

- Not at all                      \_\_\_ ;
- To a Very Small Extent        \_\_\_ ;
- To a Moderate Extent         \_\_\_ ;
- To a Great Extent             \_\_\_ ;
- To a Very Great Extent       \_\_\_ ;



8. How would you classify your management level or function?

- Top Management \_\_\_\_\_ ;
- Middle Management \_\_\_\_\_ ;
- Supervisory Management \_\_\_\_\_ ;
- Professional \_\_\_\_\_ ;
- Other \_\_\_\_\_ ;

Please write in the title of your position: \_\_\_\_\_

9. How many years have you been in your present position in the organization? \_\_\_\_\_ years

10. How many years have you been in your present firm? \_\_\_\_\_ years

11. How many years of decision making experience would you estimate you have accumulated? \_\_\_\_\_ years

12. Please check the appropriate age grouping:

- Less than 30 yrs. \_\_\_\_\_ ; 31-35 yrs. \_\_\_\_\_ ; 36-40 yrs. \_\_\_\_\_ ;
- 41-45 yrs. \_\_\_\_\_ ; 46-50 yrs. \_\_\_\_\_ ; 51-55 yrs. \_\_\_\_\_ ;
- 56-60 yrs. \_\_\_\_\_ ; Over 60 yrs. \_\_\_\_\_ ;

13. Highest Educational Level achieved before entering the MBA program: \_\_\_\_\_

14. Field or subject in which highest educational level achieved: \_\_\_\_\_

Code No. \_\_\_\_\_  
(To maintain  
confidentiality)

Section 2: Instructions

The following section consists of statements regarding your perceptions of and attitudes towards use of computers in decision-making activities in your organization.

The term "organization" includes all personnel who ultimately report to your immediate superior, i.e., your subordinates, your peers and their subordinates, and your immediate superior.

Please respond to each question in TWO different ways: FIRST, how important IS the statement as it applies to your organization at present?

SECOND, in your judgment, how important SHOULD the statement BE in your organization?

Please note again that the term "organization" includes all personnel who ultimately report to your immediate superior.

KEY TO ANSWERS:

STRONGLY AGREE (SA) : To indicate if you strongly agree with the statement as applied to your organization.

AGREE (A) : If you mildly agree with the statement as applied to your organization.

NEUTRAL (N) : If you are neutral or have no opinion as to the application of this statement to your organization.

DISAGREE (D) : If you mildly disagree with the statement as applied to your organization.

STRONGLY DISAGREE (SD) : If you strongly disagree with the statement as applied to your organization.

Open-Ended Questions: These are included to allow you to qualify your answer or clarify any assumptions made. If the space provided is insufficient, please continue to the other side of the page.

AN EXAMPLE: A sample statement might read as follows:

THE PLANNING PROCESS IS INDISPENSABLE IN MY ORGANIZATION.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	ⓓ	SD
SHOULD BE	ⓈA	A	N	D	SD

The first line of your answer (for IS) indicates your perception that the planning process is not really indispensable in your organization.

The second line of your answer (for SHOULD BE) reflects your strong perception that the planning process should be indispensable in your organization.

1. THE DECISION MAKING PROCESS IN MY ORGANIZATION ALLOWS FOR INCLUSION OF JUDGMENTAL INPUT FROM MANAGERS.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: In what way does the inclusion (or lack) of judgmental input occur, or should occur?

2. IN MY ORGANIZATION, MANAGEMENT GIVES SUPPORT TO THE USE OF COMPUTER-BASED DECISION SYSTEMS FOR DECISION MAKING PURPOSES.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: In what ways is (or lack of) management support expressed? How should it be?

3. THE DECISION MAKING PROCEDURES USED IN MY ORGANIZATION CLEARLY INCLUDE THE IMPACT OF UNCONTROLLABLE EXTERNAL FACTORS SUCH AS ECONOMIC OR SOCIAL TRENDS.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: How are uncontrollable external factors included in decision making procedures? How should they be?

4. MANAGERS IN MY ORGANIZATION DELEGATE THE QUANTITATIVE ANALYSIS ASPECTS OF THEIR DECISION MAKING FUNCTIONS TO A TECHNICAL PERSON SUCH AS AN ANALYST.

	<u>Strongly</u> <u>Agree</u>	Agree	Neutral	Disagree	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: What is your perception of the manager's activities in this area? What should they be doing?

5. IN MY ORGANIZATION, OUTSIDE CONSULTANTS ARE HIRED FOR USE OF COMPUTER-BASED DECISION SYSTEMS.

	<u>Strongly</u> <u>Agree</u>	Agree	Neutral	Disagree	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: How is the use of consultants viewed by managers?  
How should it?



6. IN MY ORGANIZATION, COMPUTER-BASED DECISION SYSTEMS HAVE BEEN USED IN THE LAST TWELVE MONTHS IN SUPPORT OF OUR DECISION MAKING ACTIVITIES.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: In your organization, what accounts for the acceptance (or lack) of computer-based decision systems? What would be required to change the situation to as it should be?

7. IN MY ORGANIZATION, MANAGERS KNOW HOW TO MAKE EFFECTIVE USE OF COMPUTER-BASED DECISION SYSTEMS?

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: How would you explain the competence (or lack) of managers in making use of computer-based decision systems? What is necessary to change the situation to as it should be?

8. IN MY ORGANIZATION, THE GOALS OF A COMPUTER-BASED  
DECISION SYSTEM ARE DEFINED EXPLICITLY IN TERMS OF THE  
DECISIONS IT WILL ASSIST.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: What is your basis for saying that?

9. TECHNICAL ASPECTS OF COMPUTER-BASED DECISION SYSTEMS HAVE RETARDED THE DEVELOPMENT OF TIMELY DECISION-MAKING INFORMATION IN MY ORGANIZATION.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: What did you interpret the words "technical aspects" to include? What is required to change the situation to as it should be?

10. IN MY WORK, I PERSONALLY MAKE USE OF COMPUTER-BASED  
DECISION SYSTEMS.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD

Q: What do you consider as the most important factors  
which support (or obstruct) your use of computer-  
based decision systems? What would be required to  
change the situation to as it should be?

September, 1982

To Respondents of  
Questionnaire Section 3 for Research Study on  
Managerial Use of Computer-Based Decision Systems

Thank you for your past assistance with providing data for this research study. It is much appreciated.

This questionnaire probes a little more into your attitudes and perceptions towards the use of computers. To allow you to explain or qualify your responses, open-ended questions have been posed for each aspect of the subject being covered. I hope you will find these questions interesting.

As before, the questionnaire has been assigned a code number to maintain confidentiality of your responses. Only the researcher will be aware of your identity.

You can help by returning the completed questionnaire at your earliest convenience to any one of the following:

- 1) Ronnie Brumec at the MBA office (or at dinners at SFU).
- 2) My mail slot in the General Office (AQ 5100).
- 3) Mail it to me at B.C.I.T.:

D.K. Chowdhury  
Marketing Management Department  
B.C.I.T.  
3700 Willingdon Avenue  
Burnaby, B.C.  
V5G 3H2

I expect to present the results of my study to your class at the earliest convenient opportunity. I regard this as a very interesting subject for research, and I hope you do, too.

Thank you for your cooperation.

Yours truly,

D.K. Chowdhury

Code No. \_\_\_\_\_  
(To maintain  
confidentiality)

Section 3: Instructions

The following section consists of statements regarding your perceptions of and attitudes towards use of computers in planning-related activities in your organization.

The term "organization" includes all personnel who ultimately report to your immediate superior, i.e., your subordinates, your peers and their subordinates, and your immediate superior.

Please respond to each question in THREE different ways:  
FIRST, how important IS the statement as it applies to your organization at present?

SECOND, in your judgment, how important SHOULD the statement BE in your organization?

THIRD, having used a Decision Support System like IFPS, how important would the statement be if a Decision Support System (DSS) such as IFPS were available and supported technically for USE in your organization?

Please note again that the term "organization" includes all personnel who ultimately report to your immediate superior.

KEY TO ANSWERS:

STRONGLY AGREE (SA) : To indicate if you strongly agree with the statement as applied to your organization.

AGREE (A) : If you mildly agree with the statement as applied to your organization.

NEUTRAL (N) : If you are neutral or have no opinion as to the application of this statement to your organization.

DISAGREE (D) : If you mildly disagree with the statement as applied to your organization.

STRONGLY DISAGREE (SD) : If you strongly disagree with the statement as applied to your organization.

Open-Ended Questions: These are included to allow you to qualify your answer or clarify any assumptions made. If the space provided is insufficient, please continue to the other side of the page.

AN EXAMPLE: A sample statement might read as follows:

THE PLANNING PROCESS IS INDISPENSABLE IN MY ORGANIZATION.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	Ⓓ	SD
SHOULD BE	ⒺSA	A	N	D	SD
IF DSS USED	SA	A	ⒺN	D	SD

The first line of your answer (for IS) indicates your perception that the planning process is not really indispensable in your organization.

The second line of your answer (for SHOULD BE) reflects your strong perception that the planning process should be indispensable in your organization.



The third line of your answer (for IF DSS USED) indicates that in your perception the availability of a DSS system in your organization would not materially change the present situation regarding the role of the planning process in your organization. It would also not be a useful aid in achieving the SHOULD BE status, i.e. a DSS is not the 'answer' in this situation.

1. THE DECISION MAKING PROCESS IN MY ORGANIZATION ALLOWS FOR INCLUSION OF JUDGMENTAL INPUT FROM MANAGERS.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: In what way does the inclusion (or lack) of judgmental input occur, or should occur? How would using a DSS help get to where you SHOULD BE?

2. IN MY ORGANIZATION, MANAGEMENT GIVES SUPPORT TO THE USE OF COMPUTER-BASED DECISION SYSTEMS FOR DECISION MAKING PURPOSES.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: In what ways is (or lack of) management support expressed? How should it be? How would using a DSS help to get to where you SHOULD BE?

3. THE DECISION MAKING PROCEDURES USED IN MY ORGANIZATION CLEARLY INCLUDE THE IMPACT OF UNCONTROLLABLE EXTERNAL FACTORS SUCH AS ECONOMIC OR SOCIAL TRENDS.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: How are uncontrollable external factors included in decision making procedures? How should they be? How would using a DSS help get to where you SHOULD BE?

4. MANAGERS IN MY ORGANIZATION DELEGATE THE QUANTITATIVE ANALYSIS ASPECTS OF THEIR DECISION MAKING FUNCTIONS TO A TECHNICAL PERSON SUCH AS AN ANALYST.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: What is your perception of the manager's activities in this area? What should they be doing? How would using a DSS help get to where you SHOULD BE?

5. IN MY ORGANIZATION, OUTSIDE CONSULTANTS ARE USED FOR USE OF COMPUTER-BASED DECISION SYSTEMS.

	<u>Strongly</u> <u>Agree</u>	Agree	Neutral	Disagree	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: How is the use of consultants viewed by managers?  
How should it be? How would using a DSS help get to  
where you SHOULD BE?

6. IN MY ORGANIZATION, COMPUTER-BASED DECISION SYSTEMS HAVE BEEN USED IN THE LAST TWELVE MONTHS IN SUPPORT OF OUR DECISION MAKING ACTIVITIES.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: In your organization, what accounts for the acceptance (or lack) of computer-based decision systems? What should be required to change the situation to as it should be? How would using a DSS help get to where you SHOULD BE?

7. IN MY ORGANIZATION, MANAGERS KNOW HOW TO MAKE EFFECTIVE USE OF COMPUTER-BASED DECISION SYSTEMS.

	<u>Strongly</u> <u>Agree</u>	Agree	Neutral	Disagree	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: How would you explain the competence (or lack) of managers in making use of computer-based decision systems? What is necessary to change the situation to as it should be? How would using a DSS help get to where you SHOULD BE?



8. IN MY ORGANIZATION, THE GOALS OF A COMPUTER-BASED DECISION SYSTEM ARE DEFINED EXPLICITLY IN TERMS OF THE DECISIONS IT WILL ASSIST.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: What is your basis for saying that? How would using a DSS help get to where you SHOULD BE?

9. TECHNICAL ASPECTS OF COMPUTER-BASED DECISION SYSTEMS HAVE RETARDED THE DEVELOPMENT OF TIMELY DECISION MAKING INFORMATION IN MY ORGANIZATION.

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: What did you interpret the words "technical aspects" to include at the top of your list? What is required to change the situation to as it should be? How would using a DSS help get to where you SHOULD BE?

10. IN MY WORK, I PERSONALLY MAKE USE OF COMPUTER-BASED  
DECISION SYSTEMS.

	<u>Strongly</u> <u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly</u> <u>Disagree</u>
IS	SA	A	N	D	SD
SHOULD BE	SA	A	N	D	SD
IF DSS USED	SA	A	N	D	SD

Q: What do you consider the most important factors which support (or obstruct) your use of computer-based decision systems? What would be required to change the situation to as it SHOULD BE?

September, 1982

To Respondents of  
Questionnaire Section 4 for Research Study on  
Managerial Use of Computer-Based Decision Systems

Thank you for all your help with this research study. You may not have realized that you are part of a "select" group of managers who have attempted to develop their own decision support systems. That experience is what we are trying to capture in this research study.

The questionnaire refers only to your DSS project and some associated factors. A variety of statements are made, whose impact you are in a good position to assess through your DSS experience. Open-ended questions have been posed to allow you to explain or qualify your responses. I hope you will find these questions interesting.

As before, the questionnaire has been assigned a code number to maintain confidentiality of your responses. Only the researcher will be aware of your identity.

You can help by returning the completed questionnaire at your earliest convenience to any one of the following:

- 1) Ronnie Brumec at the MBA office (or at dinners at SFU).
- 2) My mail slot in the General Office (AQ 5100).
- 3) Mail it to me at B.C.I.T.:

D.K. Chowdhury  
Marketing Management Department  
B.C.I.T.  
3700 Willingdon Avenue  
Burnaby, B.C.  
V5G 3H2

I expect to present the results of my study to your class at the earliest convenient opportunity. I regard this as a very interesting subject for research, and I hope you do, too.

Thank you for your cooperation.

Yours truly,

D.K. Chowdhury

Code No. \_\_\_\_\_  
(To maintain  
confidentiality)

Section 4: Instructions

This section of the questionnaire refers specifically to the DSS project you undertook as an assignment in your MIS course last spring.

Listed below are a number of problems, which have been reported in DSS developments elsewhere.

Please indicate your assessment of each factor as it affected your own project. If a factor in any way influenced the development of your DSS, please indicate in the space provided below the question:

- WHEN DID THE PROBLEM ARISE?
- HOW IT WAS RECOGNIZED?
- WHAT STEPS YOU TOOK TO OVERCOME THE PROBLEM?
- WITH WHAT SUCCESS?
- DID IT CREATE ANY NEW PROBLEMS?

Note that more than one problem can easily occur during the development of a DSS.

KEY TO ANSWERS:

EXTREME : The problem was severe enough to completely stop the development of the DSS as originally planned. Possible actions include abandonment of the project, or a major restatement of goals.

- GREAT : The problem impacted DSS development considerably, but did not bring it to a complete stop. Possible actions include creative problem solving techniques.
- SOME : The problem impacted DSS development to some extent, but it was possible to continue and obtain usable results from the DSS.
- LITTLE : The problem impacted DSS development to a minor extent, but was easily overcome.
- NOT AT ALL: Self-explanatory.

AN EXAMPLE: A sample problem might be:

OVEROPTIMISM AMONG DEVELOPERS IN SYSTEM DESIGN

Check one (to indicate severity):

Extreme \_\_\_\_\_; Great \_\_\_\_\_; Some \_\_\_\_\_;

Little \_\_\_\_\_; Not at all \_\_\_\_\_.

Comments regarding Problem/Resolution/After effects:

The problem impacted DSS development efforts to a great degree, mainly because the entire team was caught in their overoptimism. The problem was recognized just two weeks from the deadline for the project completion. It was caused because we had not been specific enough about the output we wanted, and how we would use the results. We resolved the problem by down scaling our design specifications, and were able to meet the deadline. It also meant many long and mistake-ridden sessions on the computer terminal. We ended with a sense of disappointment that the rewards were not commensurate with our efforts. Next time, we'll know better.

Problem Types

1. MULTIPLE USERS OR IMPLEMENTERS CAUSING  
COMMUNICATION PROBLEMS

Extreme

Great

Some

Little

Not at all

Comments: Problem/Resolution/After effects.



2. MULTIPLE USERS OR IMPLEMENTERS LEADING TO INABILITY TO INCORPORATE MULTIPLICITY OF INTERESTS.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Extreme	Great	Some	Little	Not at all

Comments: Problem/Resolution/After effects.

3. OVEROPTIMISM AMONG DSS DESIGNERS OR USERS DURING SOME PHASE OF DEVELOPMENT.

Extreme

Great

Some

Little

Not at all

Comments: Problem/Resolution/After effects.

4. NEED FOR ADDITIONAL COMPUTER TIME AUTHORIZATION FOR PROJECT.

Extreme

Great

Some

Little

Not at all

Comments: Problem/Resolution/After effects.

5. TECHNICAL PROBLEMS WITH COMPUTER TERMINAL USAGE.

Extreme

Great

Some

Little

Not at all

Comments: Problem/Resolution/After effects.

6. UNFAMILIARITY WITH SPECIFICATIONS OF DSS LANGUAGE,  
LEADING TO MISTAKES.

Extreme

Great

Some

Little

Not at all

Comments: Problem/Resolution/After effects.

7. LACK OF RELEVANCE OF PROJECT TO MY ORGANIZATION.

Extreme

Great

Some

Little

Not at all

Comments: Problem/Resolution/After effects.

8. PROJECT DEADLINE EXPIRED.

Extreme

Great

Some

Little

Not at all

Comments: Problem/Resolution/After effects.

9. LACK OF COMMITMENT TO USE THE DSS BEING DEVELOPED.

Extreme

Great

Some

Little

Not at all

Comments: Problem/Resolution/After effects.



10. WERE THERE ANY OTHER PROBLEMS WHICH HAD AN IMPACT ON DSS DEVELOPMENT? TO WHAT EXTENT?

Extreme

Great

Some

Little

Comments on the problems, their resolution and any after effects.

11. WHAT TYPE OF DSS DID YOU DEVELOP? CHECK ONE FROM THE LIST BELOW WHICH MOST CLOSELY DESCRIBES IT.

- a. Retrieving a single item of information \_\_\_\_\_
- b. A Data Analysis system to allow the manipulation of data on an ad hoc basis \_\_\_\_\_
- c. Providing prespecified aggregations of data in the form of reports (e.g. accounting type reports) \_\_\_\_\_
- d. A model incorporating heuristics, i.e. 'rules of thumb' \_\_\_\_\_
- e. A model incorporating optimization procedures (such as linear programming) \_\_\_\_\_
- f. A model which represents the consequences of actions (e.g. risk analysis) \_\_\_\_\_
- g. A model which suggests a decision (e.g. calculating prices, insurance rates, inventory allocation) \_\_\_\_\_

12. What time horizon was assumed for decision making purposes in the DSS developed?

- Short Term, less than 1 year
- Intermediate Term, more than 1 year and less than 5 years
- Long Term, more than 5 years

13. What type of decisions were modelled in the DSS?

Check one.

Routine

Ad Hoc (i.e. one of a kind or non-recurring)

14. What aspect of the firm did the DSS attempt to model?

One specific function  
(e.g. Marketing or Finance, etc.)

Name of function: \_\_\_\_\_

Corporate, i.e. multi-function decisions

15. Was the DSS problem one which has actually occurred in one of the team member organizations?

Yes

No

16. What name or description did you give the DSS?

\_\_\_\_\_  
\_\_\_\_\_

17. Overall, in your opinion, how successful was the DSS project effort?

Not at all \_\_\_\_\_ ;

To a Very Small Extent \_\_\_\_\_ ;

To a Moderate Extent \_\_\_\_\_ ;

To a Great Extent \_\_\_\_\_ ;

To a Very Great Extent \_\_\_\_\_ ;

Section 5: Instructions (Unstructured Interview)

These open-ended questions are aimed at capturing the highlights of your experiences during the DSS project. You may approach these questions in any sequence you desire.

1. How did developing a DSS (as a team) compare with previous experiences in (group) decision-making?
2. How were you able to agree on a problem definition for your DSS? How did it compare with the original project outline written for the instructor? Did the problem definition undergo any changes during the development process?
3. How would you characterize the DSS development process? As a sustained effort, or as a pulsing activity?
4. Did you each keep to the same project activities throughout the development of the DSS? What major changes do you recall as taking place?
5. How did you decide when the project was complete? If it wasn't for a matter of time, what changes or modifications would you have considered to the DSS?
6. How did you share (plan) the work of operating the computer terminal? Do you feel confident of using it again?
7. In hindsight, what benefits did you derive from the involvement with the DSS project? Was it worth the cost?

8. Did the exercise of collecting the data in the manner required by the DSS give you any insights into the problem being modelled? Was the input data easy to acquire?
9. Under what circumstances would you make use of a DSS on a future planning or decision-making exercise?
  - For a MBA assignment?
  - In your own organization?
10. What is the likelihood of your using a DSS, one you develop or one developed elsewhere?
11. How helpful was IFPS for the specific problem tackled?
12. How likely is it for this DSS application to be transferred to a corporate environment?
13. How easy would it be for someone other than a team member to use the model?
  - What additional information would be required for them to do so? Is it available?
  - Was the model developed with others in mind?
14. Could you cost justify the model development effort?  
How?
15. Did you test or validate the model for accuracy or reasonableness of answers? How?

16. How would you communicate the results generated by the model to a colleague? Would you do so primarily:
  - using IFPS output directly (reports or graphs)?
  - using reformatted IFPS output?
  - in a descriptive report format?
  
17. How would you attempt to communicate the complexity of the model to a colleague? Would you attempt to hide its complexity and treat it as a "black box"?
  
18. At what level of management is this DSS aimed?  
Senior, Middle or Operational?
  
19. Were there any unusual situations or problems during the project that had you completely at a loss? How did you cope?
  
20. Any experimental information you would like to share with other managers wishing to develop models?

Section 6: Additional Information on DSS Project

Answers to these questions are in a ranking from:

- 1 = Not at all
- 2 = To a little extent
- 3 = To some extent
- 4 = To a great extent
- 5 = To a very great extent

To what extent did you (as a team, if more than one person)  
involved:

1. Develop a prototype (i.e., a working version but thrown away) of the final model in the process development? \_\_\_\_\_
2. Develop the final model in an evolutionary fashion, i.e., adding to or making changes in a simpler but working model (i.e., as building blocks)? \_\_\_\_\_
3. Develop a series of small models to solve the problem (vs. building one model which handled everything)? \_\_\_\_\_
4. Keep the model simple (in logic, calculations, etc.)? \_\_\_\_\_
5. Hide the complexity of the model from the report (i.e., use a simple layout with not too many numbers)? \_\_\_\_\_

6. Avoid making changes in the model once it got working (e.g., as in finetuning, adding bells and whistles, etc.)? \_\_\_\_\_
7. Tailor the model's capabilities to the user's capabilities (vs. putting in fancy features of IFSP (or any DSS) just because you could do so)? \_\_\_\_\_
8. Feel committed to developing the model to its final form? \_\_\_\_\_
9. Feel you participated in developing the model to its final form? \_\_\_\_\_
10. Need to "sell" the user that the model could "do the job"? \_\_\_\_\_
11. Change the definition or scope of what the model was to achieve since the beginning of the project (e.g., from the project outline)? \_\_\_\_\_
12. Feel the project was a "sustained" (vs. on-off-on) effort? \_\_\_\_\_
13. Derive any insights into the problem from collecting/analyzing the data prior to inputting it in the model? \_\_\_\_\_
14. Experience difficulties in collecting the data required? \_\_\_\_\_
15. Feel you would make additional use of models (in future) developed in a DSS language? \_\_\_\_\_



- 16. Feel this model could be transferred to a corporate organizational setting (assuming computer facilities available)? \_\_\_\_\_
  
- 17. Feel you could justify the costs and time involved in developing this model? \_\_\_\_\_
  
- 18. Derive any insights into the problem through modelling it? \_\_\_\_\_

RESPONDENT CODE #: \_\_\_\_\_

APPENDIX 2

SPSS Data Codebook and Program Listings

This appendix presents a codebook for this research study, i.e. a listing and description of the variables used in the statistical analysis, and a listing of the SPSS computer programs.

The codebook includes the variable's meaning, the codes used and their meanings, where the variable is punched on the data cards, and the brief name used to reference the variable in SPSS. The leftmost column contains the sequence number of each variable. The next column contains the card-column numbers in which each variable has been punched on the data cards. The third column reports the SPSS variable names, and the right hand column contains the detailed description of each variable and an explanation of the coded values.

Data on the first card applies to both the control and test sample groups, and is used for an analysis of inter-sample differences. Data on the second card applies only to the test sample group of managers who had hands-on experience in developing a DSS; this data is used for analysis within the test sample.

Card Number 1

Card Columns	SPSS Var.	Variable Description	Codes
2	YRCØDE	Identification number of the respondent group	2 = second year MBA students who have taken OR, but not MIS 3 = third year students who have taken OR, but not MIS 4 = third year students who have taken OR <u>and</u> MIS
3 - 4	RESPID	Respondent identification number within the group	
5	XPDSSA	Respondent experience and knowledge of DSS before enrolling in MBA	1 = Not at all, to 5 = Very Great Extent
6	XPDSSB	Respondent experience and knowledge of DSS at present	Same as XPDSSA
7	XPDSSØRG	DSS knowledge provided by respondent's organization	Same as XPDSSA
8	DSSVIEW	Respondent's overall attitude when working with DSS	1 = Very Negative, to 5 = Very Positive
9	STBLØRG	Stability as a characteristic of respondent's organization	Same as XPDSSA

Card Number 1 - Continued

Card Columns	SPSS Var.	Variable Description	Codes
10	CMPINØRG	Competition with other firms as a characteristic of respondent's orgzn.	Same as XPDSSA
11	TIMPRØRG	Time Pressures as a characteristic of respondent's organization	Same as XPDSSA
12	MGTLVØRG	Respondent's management level in his organization	<ol style="list-style-type: none"> <li>1. Top Management</li> <li>2. Middle Management</li> <li>3. Supervisory Management</li> <li>4. Professional</li> <li>5. Other</li> </ol>
13-14	YRSINJØB	No. of years respondent has been in present position in organization	Exact Value
15-16	YRSINCØ	No. of years respondent has been in present firm	Exact Value
17-18	YRSINDM	No. of years respondent has accumulated decision making experience	Exact Value
19	AGEGRP	Age grouping for respondent	<ol style="list-style-type: none"> <li>1. Less than 30 yrs</li> <li>2. 31-35 years</li> <li>3. 36-40 years</li> <li>4. 41-45 years</li> <li>5. 46-50 years</li> </ol>

Card Number 1 - Continued

Card Columns	SPSS Var.	Variable Description	Codes
19	AGEGRP	Age grouping for respondent	6. 51-55 years 7. 56-60 years 8. Over 60 years
20	SEX	Respondent's sex	1. Male 2. Female
21	EDULVL	Highest educ. level achieved before MBA enrollment	1. Less than High School 2. High School 3. Less than College or Univ/graduation 4. Diploma 5. Professional Registration or Bachelor's degree 6. Master's degree 7. Doctorate
22	EDUFLD	Field in which highest education level achieved	1. Arts 2. Sciences 3. Education 4. Nursing 5. Social Work 6. Public Administration 7. Engineering or Technology 8. Business Admin. 9. Other

Card Number 1 - Continued

Card Columns	SPSS Var.	Variable Description	Codes
23	Q1IS	Question 1: Response to IS	0. Missing Value 1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree
24	Q1SH	Question 1: SHOULD BE	Same as Q1IS
25	Q2IS	Question 2: IS	Same as Q1IS
26	Q2SH	Question 2: SHOULD BE	Same as Q1IS
27	Q3IS	Question 3: IS	Same as Q1IS
28	Q3SH	Question 3: SHOULD BE	Same as Q1IS
29	Q4IS	Question 4: IS	Same as Q1IS
30	Q4SH	Question 4: SHOULD BE	Same as Q1IS
31	Q5IS	Question 5: IS	Same as Q1IS
32	Q5SH	Question 5: SHOULD BE	Same as Q1IS
33	Q6IS	Question 6: IS	Same as Q1IS
34	Q6SH	Question 6: SHOULD BE	Same as Q1IS
35	Q7IS	Question 7: IS	Same as Q1IS
36	Q7SH	Question 7: SHOULD BE	Same as Q1IS
37	Q8IS	Question 8: IS	Same as Q1IS
38	Q8SH	Question 8: SHOULD BE	Same as Q1IS
39	Q9IS	Question 9: IS	Same as Q1IS
40	Q9SH	Question 9: SHOULD BE	Same as Q1IS

Card Number 1 - Continued

Card Columns	SPSS Var.	Variable Description	Codes
41	Q10IS	Question 10: IS	Same as Q1IS
42	Q10SH	Question 10: SHOULD BE	Same as Q1IS
43	TYP <del>O</del> RGST	Organizational status	1 = Head Office 2 = Branch Office 3 = Other, including self-employed
44	TYP <del>O</del> RGFN	Organizational Function	1 = "Staff" Function 2 = Computer Services 3 = "Line" Function
45-46	TYPIND	Industry in which organization operates	1 = Manufacturing 2 = Distribution 3 = Federal Gov't. 4 = Prov./Local Gov't. 5 = Utility (Power, Communications, Transportation) 6 = Medical 7 = Insurance 8 = Education 9 = Consulting Services 10 = Finance 11 = Tourism (incl. hotels)



Card Number 1 - Continued

Card Columns	MPSS Var.	Variable Description	Codes
45-46	TYPIND	Industry in which organi- zation operates	12 = Computers 13 = Social Services 14 = Real Estate/ Land Devel. 15 = Other

Card Number 2

Card Columns	SPSS Var.	Variable Description	Codes/Values
5	Q1DSS	Question 1: IF DSS USED	Same as Q1IS
6	Q2DSS	Question 2: IF DSS USED	Same as Q1IS
7	Q3DSS	Question 3: IF DSS USED	Same as Q1IS
8	Q4DSS	Question 4: IF DSS USED	Same as Q1IS
9	Q5DSS	Question 5: IF DSS USED	Same as Q1IS
10	Q6DSS	Question 6: IF DSS USED	Same as Q1IS
11	Q7DSS	Question 7: IF DSS USED	Same as Q1IS
12	Q8DSS	Question 8: IF DSS USED	Same as Q1IS
13	Q9DSS	Question 9: IF DSS USED	Same as Q1IS
14	Q10DSS	Question 10: IF DSS USED	Same as Q1IS
15	PR1	Project Problem 1: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
16	PR2	Project Problem 2: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
17	PR3	Project Problem 3: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
18	PR4	Project Problem 4: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
19	PR5	Project Problem 5: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme

Card Number 2 - Continued

Card Columns	SPSS Var.	Variable Description	Codes/Values
20	PR6	Project Problem 6: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
21	PR7	Project Problem 7: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
22	PR8	Project Problem 8: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
23	PR9	Project Problem 9: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
24	PR10	Project Problem 10: Response	0 = Missing Value 1 = Not at all, to 5 = Extreme
25	DSSTYPE	Type of DSS developed	0 = Missing Value 1 = Single Hem of Info 2 = Ad Hoc Data Manipulate 3 = Data aggre- gation 4 = Heuristics 5 = Optimization 6 = Representa- tional 7 = Suggestion

Card Number 2 - Continued

Card Columns	SPSS Var.	Variable Description	Codes/Values
26	DSSTIMF	Time Frame assumed in DSS project	1 = Short Term, less than 1 yr 2 = Interm. Term, 1 - 5 yrs. 3 = Long Term, more than 5 yrs
27	DSSDECTY	Type of decision modelled	1 = Routine 2 = Ad Hoc
28	DSSFN	Functional management modelled by DSS	1 = Multifunction 2 = Production (including Inventory) 3 = Marketing 4 = Finance 5 = Personnel/ Administration 6 = Other
29	DSSPRBTY	Problem Type: Actually occurred or conjured	1 = Real Problem 2 = Other
30	DSSEVAL	Overall success of DSS project	From 1 = Not at all, to 5 = Very Great Extent
31	DSSTRGY1	Strategy 1: Use prototype	From 1 = Not at all, to 5 = Very Great Extent

Card Number 2 - Continued

Card Columns	SPSS Var.	Variable Description	Codes/Values
32	DSSTRGY2	Strategy 2: Evolutionary or modular approach	From 1 = Not at all, to 5 = Very Great Extent
33	DSSTRGY3	Strategy 3: Develop a series of tools	From 1 = Not at all, to 5 = Very Great Extent
34	DSSTRGY4	Strategy 4: Keep the model simple	From 1 = Not at all, to 5 = Very Great Extent
35	DSSTRGY5	Strategy 5: Hide the complexity of model e.g. in output	From 1 = Not at all, to 5 = Very Great Extent
36	DSSTRGY6	Strategy 6: Avoid changes in model	From 1 = Not at all, to 5 = Very Great Extent
37	DSSTRGY1	Strategy 7: Tailor system to user capability	From 1 = Not at all, to 5 = Very Great Extent

Card Number 2 - Continued

Card Columns	SPSS Var.	Variable Description	Codes/Values
38	DSSTRGY8	Strategy 8: Get user commitment	From 1 = Not at all, to 5 = Very Great Extent
39	DSSTRGY9	Strategy 9: Obtain user participation	From 1 = Not at all, to 5 = Very Great Extent
40	DSSTRGY10	Strategy 10: "Sell" user on system	From 1 = Not at all, to 5 = Very Great Extent
41	DSPRDFCH	Degree of change in model/ problem definition during development	From 1 = Not at all, to 5 = Very Great Extent
42	DSDEVPRQ	DSS development process as a sustained effort	From 1 = Not at all, to 5 = Very Great Extent
43	DSDATAI	Insights from collecting data	From 1 = Not at all, to 5 = Very Great Extent
44	DSDATAD	Difficulty of data collection	From 1 = Not at all, to 5 = Very Great
45	ADDLUSE	Expected future use of DSS models	From 1 = Not at all, to 5 = Very Great Extent

Card Number 2 - Continued

Card Columns	SPSS Var.	Variable Description	Codes/Values
46	DSS'TRANS	Transferability of DSS model to corporate environment	From 1 = Not at all, to 5 = Very Great Extent
47	DSCØSTJ	Cost justification of model development	From 1 = Not at all, to 5 = Very Great Extent
48	DSTMSIZE	Size of DSS Project Team	1 = 1 person teams 2 = 2 person teams
49-50	DSSGRP	Project group number	Exact Value
51	DSPRØBI	Insights into problem from undertaking model development	From 1 = None at all to 5 = Very Great Extent

DEFAULT SPACE ALLOCATION.. 436 TRANSFORMATIONS  
 WORKSPACE 305544 BYTES 1746 RECORD VALUES & LAG VARIABLES  
 TRANSPOSE 43548 BYTES 6984 IF/COMPUTE OPERATIONS

1	RUN-NAME	BUN-MATH-TEST	SAMPLE
2	FILE NAME	STUDY OF MANAGER-DEVELOPER DSS	
3	DATA LIST	FIXED(2) 1 YRCDJF 2 RESPID 3-4 XPDSSA 5	XPDSSB 6,
4		XPDSSORG 7, DSSVTFM 8, STALORG 9, CMTVORG 10	YRSDJNC 15-16,
5		YRSDJNC 11, MGTLVORG 12, YRSDJNC 13-14	YRSDJNC 22,
6		YRSDJNC 17-18, AGEGRP 19, SEX 20, EDULVL 21	EDULVL 28,
7		Q1LS 23, Q1SH 24, Q2LS 25, Q2SH 26, Q3LS 27	Q3SH 34,
8		Q4LS 29, Q4SH 30, Q5LS 31, Q5SH 32, Q6LS 33	Q6SH 40,
9		Q7LS 35, Q7SH 36, Q8LS 37, Q8SH 38, Q9LS 39	Q9SH 44,
10		Q10LS 41, Q10SH 42, YPORGST 43, YPORGFY 44	TYPIND 45-46
11		Q11LS 41, Q11SH 42, YPORGST 7, Q11DSS 8	Q11DSS 9, Q6DSS 10,
12		Q12LS 11, Q12SH 12, YPORGST 13, Q12DSS 14	PR1 15, PR2 16,
13		Q13LS 17, Q13SH 18, PR5 19, PR6 20, PR7 21	PR8 23, PR10 24,
14		DSSVTFM 25, DSSVTFM 26, DSSDEF 27, DSSDEF 28	DSSPRBTY 29,
15		DSSDEF 30, DSSDEF 31, DSSDEF 32, DSSDEF 33	DSSDEF 33,
16		DSSDEF 34, DSSDEF 35, DSSDEF 36, DSSDEF 37	DSSDEF 37,
17		DSSDEF 38, DSSDEF 39, DSSDEF 40, DSSDEF 41	DSSDEF 41,
18		DSSDEF 42, DSSDEF 43, DSSDEF 44, DSSDEF 45	DSSDEF 45,
19		DSSDEF 46, DSSDEF 47, DSSDEF 48, DSSDEF 49	DSSDEF 49-50,
20		DSSDEF 51, DSSDEF 52, DSSDEF 53, DSSDEF 54	DSSDEF 54,

THE DATA LIST PROVIDES FOR 86 VARIABLES AND 2 RECORDS (\*CARDS\*) PER CASE.

LIST OF THE CONSTRUCTED FORMAT STATEMENT.

(1X,F1-0,F2-0,RE1-0,RE2-0,2AE1-0,F2-0,74X,44E1-0,F2-0,F1-0)

21	INPUT MEDIUM	CARD
22 <td>LINE CASES</td> <td>29</td>	LINE CASES	29
23 <td>MISSING VALUES</td> <td>Q1LS TO PR10 (3)</td>	MISSING VALUES	Q1LS TO PR10 (3)
24 <td></td> <td>Q4LS, Q4SH, Q9LS, Q9SH (5=1) (4=2) (3=3) (2=4) (1=5)</td>		Q4LS, Q4SH, Q9LS, Q9SH (5=1) (4=2) (3=3) (2=4) (1=5)
25 <td></td> <td>Q4DSS, Q9DSS (5=1) (4=2) (2=4) (1=5)</td>		Q4DSS, Q9DSS (5=1) (4=2) (2=4) (1=5)
26 <td></td> <td>XPDSSA TO YRSDJNC (1=2) (5=4)</td>		XPDSSA TO YRSDJNC (1=2) (5=4)
27 <td></td> <td>MGTLVORG (5=4)</td>		MGTLVORG (5=4)
28 <td></td> <td>YPORGST TO YRSDJNC (1 THRU 2=1) (3 THRU 5=2)</td>		YPORGST TO YRSDJNC (1 THRU 2=1) (3 THRU 5=2)
29 <td></td> <td>AGEGRP (4 THRU 8=4)</td>		AGEGRP (4 THRU 8=4)
30 <td></td> <td>EDULVL (1 THRU 4=4)</td>		EDULVL (1 THRU 4=4)
31 <td></td> <td>Q1LS TO Q10LS (12 THRU 3=2) (4 THRU 5=3)</td>		Q1LS TO Q10LS (12 THRU 3=2) (4 THRU 5=3)
32 <td></td> <td>RESPID, RESPONDENT GROUP/</td>		RESPID, RESPONDENT GROUP/
33 <td></td> <td>RESPID, RESPONDENT ID/</td>		RESPID, RESPONDENT ID/
34 <td></td> <td></td>		



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RVNS WITH TEST SAMPLE

35	XP0SSA, DSS KNOWHOW PRE-MBA/	
36	XP0SSR, PRESENT DSS KNOWLEDGE/	
37	XP0SSP, DSS SUPPORT IN ORG./	
38	DSSVIEW, OVERALL ATTITUDE TO DSS/	
39	SMPTORG, STABILITY LEVEL OF ORG./	
40	TEMPORG, TIME PRESSURE IN ORG./	
41	CMPTVORG, PRESIDENT'S MGMT LEVEL/	
42	YPSINJDR, YEARS IN PRESENT POSITION/	
43	YPSINCO, YEARS IN PRESENT FIRM/	
44	AGEGRP, AGE GROUP/	
45	SEX, SEX OF RESPONDENT/	
46	EDUFLD, HIGHEST EDUCATIONAL LEVEL/	
47	EDUFLD, FIELD OF HIGHEST EDUC. LEVEL/	
48	Q1LSH, DEC. MKG ALLWS MGR. JUDGMENT AS INPUT/	
49	Q2LSH, DEC. MKG ALLWS MGR. JUDGMENT AS INPUT/	
50	Q3LSH, MGT. SUPPORT FOR DSS USE/	
51	Q4LSH, MGT. SUPPORT FOR DSS USE/	
52	Q5LSH, DEC. MKG INCLUDES ENVIR. FACTOR IMPACT/	
53	Q6LSH, DEC. MKG INCLUDES ENVIR. FACTOR IMPACT/	
54	Q7LSH, QUANT. ANALYSIS DELEGATED/	
55	Q8LSH, QUANT. ANALYSIS DELEGATED/	
56	Q9LSH, QUANT. ANALYSIS FOR DSS USAGE/	
57	Q0LSH, CONSULTANTS FOR DSS USAGE/	
58	Q1LSH, CONSULTANTS FOR DSS USAGE/	
59	Q2LSH, RECENT USE OF DSS/	
60	Q3LSH, RECENT USE OF DSS/	
61	Q4LSH, MGRS IN ORG EFFECTIVE WITH DSS/	
62	Q5LSH, MGRS IN ORG EFFECTIVE WITH DSS/	
63	Q6LSH, DSS TUNED TO DEC. MKG REQUIS./	
64	Q7LSH, DSS TUNED TO DEC. MKG REQUIS./	
65	Q8LSH, TECHNICAL BARRIERS TO DSS USE/	
66	Q9LSH, TECHNICAL BARRIERS TO DSS USE/	
67	Q0LSH, PERSONAL DSS USE/	
68	Q1LSH, PERSONAL DSS USE/	
69	Q2LSH, MGT. SUPPORT FOR DSS USE/	
70	Q3LSH, MGT. SUPPORT FOR DSS USE/	
71	Q4LSH, DEC. MKG INCLUDES ENVIR. FACTOR IMPACT/	
72	Q5LSH, DEC. MKG INCLUDES ENVIR. FACTOR IMPACT/	
73	Q6LSH, QUANT. ANALYSIS DELEGATED/	
74	Q7LSH, QUANT. ANALYSIS DELEGATED/	
75	Q8LSH, RECENT USE OF DSS/	
76	Q9LSH, MGRS IN ORG EFFECTIVE WITH DSS/	
77	Q0LSH, DSS TUNED TO DEC. MKG REQUIS./	
78	Q1LSH, TECHNICAL BARRIERS TO DSS USE/	
79	Q2LSH, TECHNICAL BARRIERS TO DSS USE/	
80	Q3LSH, PERSONAL DSS USE/	
81	PP1, MULTI-USER COMMUN. PROBLEMS/	
82	PP2, MULTIPLE INTERESTS/	
83	PP3, OVEROPTIMISM/	
84	PP4, ADDL. CPU AUTHORIZATION/	
85	PP5, COMPUTER TERMINAL PROBLEMS/	
86	PP6, DSS LANGUAGE PROBLEMS/	
87	PP7, PROJECT NOT RELEVANT/	
88	PP8, DEADLINE EXPIRY/	

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RUNS WITH TEST SAMPL.F

88	PRO, LACK OF COMMITMENT TO DSS/
89	PRO, OTHER PROBLEMS/
90	DSS, V, TYPE OF DSS/
91	DSS, TIME, TIME HORIZON OF PROBLEM/
92	DSS, DECISION TYPE MODELLED/
93	DSS, FUNCTIONAL ASPECT OF PROBLEM/
94	DSS, REAL OR IMAGINARY PROBLEM/
95	DSS, SEVAL, OVERALL EVALUATION OF PROJECT SUCCESS/
96	DSS, STRGY1, USE PROTOTYPING, MDD, APPROACH/
97	DSS, STRGY2, DEVELOP SERIES OF TOOLS/
98	DSS, STRGY3, KEEP MODEL SIMPLE/
99	DSS, STRGY4, INDE MODEL COMPLEXITY/
100	DSS, STRGY5, AVOID MAKING CHANGES IN MODEL/
101	DSS, STRGY6, TAILOR MODEL TO SUIT USER/
102	DSS, STRGY7, GET USER PARTICIPATION/
103	DSS, STRGY8, NEED TO SELL USER/
104	DSS, STRGY9, CHANGES IN PROJ. EFFN DURING DEVEL./
105	DSS, DEVPRO, SUSTAINED DEV. EFFORT/
106	DSS, DATA1, INSIGHTS FROM DATA COLLECTION/
107	DSS, DATA2, EFFICACY OF DATA COLLECTION/
108	DSS, DATA3, FUTURE USE OF DSS/
109	DSS, STRANS, TRANSFER PROJECT DSS TO ORG/
110	DSS, COSTJ, COST JUSTIFICATION OF DSS/
111	DSS, GRP, PROJECT GROUP NO./
112	DSS, PROJ, INSIGHTS FROM MODELING/
113	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
114	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
115	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
116	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
117	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
118	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
119	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
120	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
121	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
122	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
123	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
124	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
125	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
126	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
127	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
128	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
129	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
130	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
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138	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
139	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO
140	DSS, XROSSA TO XROSSORG, STALORG TO IMPROV, TO

VALUF LABELS

- (0) DONT KNOW
- (1) NOT AT ALL
- (2) TO A SMALL EXTENT
- (3) TO A MODERATE EXTENT
- (4) TO A GREAT EXTENT
- (5) TO A VERY GREAT EXTENT
- (6) NEGATIVE
- (7) NEGATIVE
- (8) INDIFFERENT
- (9) POSITIVE
- (10) POSITIVE
- (11) POSITIVE
- (12) POSITIVE
- (13) POSITIVE
- (14) POSITIVE
- (15) POSITIVE
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- (140) POSITIVE

MGTLVORG

- (1) TOP MANAGEMENT
- (2) MIDDLE MANAGEMENT
- (3) SUPERVISORY MGMT.
- (4) PROFESSIONAL
- (5) OTHER

AGEGRP

- (1) LESS THAN 30 YRS
- (2) 31-35 YRS
- (3) 36-40 YRS
- (4) 41-45 YRS
- (5) 46-50 YRS
- (6) 51-55 YRS

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RJNS WITH TEST SAMPL

141					
142	SFX (1)	56-60 YRS /	(7) OVER 60 YRS /		
143	(2) MALE		(8) FEMALE /		
144	EDJVL	(1) LESS THAN HIGH SCHOOL	(9) COMPLETED-HIGH SCHOOL		
145		(2) SOME COLLEGE EDUC.	(10) DIPLOMA		
146		(3) BACHELORS DEGREE	(11) MASTERS DEGREE		
147		(4) DOCTORATE /	(12) APIS		
148			(13) SCIENCES		
149			(14) EDUCATION		
150			(15) NURSING		
151			(16) SOCIAL WORK		
152			(17) PUBLIC ADMIN.		
153			(18) ENGG./IR TECHNOLGY		
154			(19) BUSINESS ADMIN.		
155			(20) OTHER /		
156			(21) OTHER /		
157			(22) OTHER /		
158			(23) OTHER /		
159			(24) OTHER /		
160			(25) OTHER /		
161			(26) OTHER /		
162	QI1S TO QI10SH				
163	QI1SS TO QI10DSS				
164	(1) STRONGLY DISAGRE				
165	(2) DISAGREE				
166	(3) NEUTRAL				
167	(4) AGREE				
168	(5) STRONGLY AGREE /				
169	DSSTYPE	(1) MISSING VALUE /			
170		(2) SINGLE ITEM OF INFO.			
171		(3) AD-HOC DATA-MANIPUL			
172		(4) DATA AGGREGATION			
173		(5) HEURISTICS			
174		(6) OPTIMIZATION			
175		(7) RISK ANALYSIS			
176		(8) SUGGESTION /			
177	DSSTIME	(1) 0 TO 1 YRS			
178		(2) 1 TO 5 YRS			
179		(3) 5 PLUS YRS			
180	DSSDECTY	(1) ROUTINE			
181		(2) AD-HOC /			
182	DSSFN	(1) MULTIFUNCTION			
183		(2) PRODUCTION			
184		(3) MARKETING			
185		(4) FINANCE			
186		(5) ADMIN.			
187	DSSPRBTY	(1) REAL-LIFE PROBLEM			
188		(2) PERSONAL /			
189	TYPORGST	(1) HEAD OFFICE			
190		(2) BRANCH OFF.			
191		(3) SELF-EMPLOYED /			
192	TYPORGFN	(1) STAFF ORG SVCS			
193		(2) COMPUTER SVCS			

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RUNS WITH TEST SAMPLE

LINE	TEST SAMPLE	TYPIND	LINE ORG. /
194	COMPUTE	A1= Q1SH-021S	(3) MANUF.
195	COMPUTE	A2= Q2SH-021S	(1) DISTRN.
196	COMPUTE	A3= Q3SH-031S	(2) FED. GOVT.
197	COMPUTE	A4= Q4SH-041S	(4) PROV. LOC. GOVT
198	COMPUTE	A5= Q5SH-051S	(5) UTILITIES
199	COMPUTE	A6= Q6SH-061S	(6) MEDICAL
200	COMPUTE	A7= Q7SH-071S	(7) INSURANCE
201	COMPUTE	A8= Q8SH-081S	(8) EDUCATION
202	COMPUTE	A9= Q9SH-091S	(9) CONSULTING
203	COMPUTE	A10= Q10SH-010S	(10) FINANCE
204	COMPUTE	A11= Q11SH-011S	(11) TOURISM
205	COMPUTE	A12= Q12SH-012S	(12) COMPUTERS
206	COMPUTE	A13= Q13SH-013S	(13) SOCIAL SVCS
207	COMPUTE	A14= Q14SH-014S	(14) REAL ESTATE
208	COMPUTE	A15= Q15SH-015S	(15) OTHER
209	COMPUTE	A16= Q16SH-016S	
210	COMPUTE	A17= Q17SH-017S	
211	COMPUTE	A18= Q18SH-018S	
212	COMPUTE	A19= Q19SH-019S	
213	COMPUTE	A20= Q20SH-020S	
214	COMPUTE	A21= Q21SH-021S	
215	COMPUTE	A22= Q22SH-022S	
216	COMPUTE	A23= Q23SH-023S	
217	COMPUTE	A24= Q24SH-024S	
218	COMPUTE	A25= Q25SH-025S	
219	COMPUTE	A26= Q26SH-026S	
220	COMPUTE	A27= Q27SH-027S	
221	COMPUTE	A28= Q28SH-028S	
222	COMPUTE	A29= Q29SH-029S	
223	COMPUTE	A30= Q30SH-030S	
224	COMPUTE	A31= Q31SH-031S	
225	COMPUTE	A32= Q32SH-032S	
226	COMPUTE	A33= Q33SH-033S	
227	COMPUTE	A34= Q34SH-034S	
228	COMPUTE	A35= Q35SH-035S	
229	COMPUTE	A36= Q36SH-036S	
230	COMPUTE	A37= Q37SH-037S	
231	COMPUTE	A38= Q38SH-038S	
232	COMPUTE	A39= Q39SH-039S	
233	COMPUTE	A40= Q40SH-040S	
234	COMPUTE	A41= Q41SH-041S	
235	COMPUTE	A42= Q42SH-042S	
236	COMPUTE	A43= Q43SH-043S	
237	COMPUTE	A44= Q44SH-044S	
238	COMPUTE	A45= Q45SH-045S	
239	COMPUTE	A46= Q46SH-046S	
240	COMPUTE	A47= Q47SH-047S	
241	COMPUTE	A48= Q48SH-048S	
242	COMPUTE	A49= Q49SH-049S	
243	COMPUTE	A50= Q50SH-050S	
244	COMPUTE	A51= Q51SH-051S	
245	COMPUTE	A52= Q52SH-052S	
246	COMPUTE	A53= Q53SH-053S	

PR4+PR5+PR6+PR7+PR8+PR9)/9  
 Q1S+Q41S+Q51S+Q61S+Q71S+Q81S+Q91S+Q101S)/10;  
 QSH=Q1SH+Q2SH+Q3SH+Q4SH+Q5SH+Q6SH+Q7SH+Q8SH+Q9SH+Q10SH)/10;  
 QDS=(Q1DSS+Q2DSS+Q3DSS+Q4DSS+Q5DSS+Q6DSS+Q7DSS+Q8DSS+Q9DSS)/10;  
 AS=(A1+A2+A3+A4+A5+A6+A7+A8+A9+A10)/10;  
 BS=(B1+B2+B3+B4+B5+B6+B7+B8+B9+B10)/10.

APPENDIX 3

Writeups for DSS Projects examined in this study

Writeups for twenty-one DSS projects reviewed in this dissertation have been collected in this appendix. These writeups are based on the information received from questionnaires, interviews conducted with each of the project teams, and on their project summary reports. Each writeup was reviewed by the respective project teams for accuracy of information included, and to ensure protection of identities, both individual and corporate.

The writeups reflect the wide variety of problems tackled by managers using a DSS approach. For each project, the nature of the problem is identified, and followed by a brief description of the input and output components of the models. For models encountering trouble spots, this has been noted in the form of anecdotal evidence from the participants. For projects deemed "successful" by their developers, the writeups have concentrated on identifying the information used and insights derived in the modelling exercise. Statistical summaries of project characteristics can be found in the main portion of the dissertation.

Eight of the projects reported here were developed by two-person teams; thirteen projects were completed by individual managers.

PROJECT 1: A DSS for Personal Financial Planning

This DSS project was unique in that it developed a case study around a DSS model. The principals in this study are the Smith family, who are attempting to balance their financial commitments with their earnings potential. Mr. Smith is caught between higher expenses because of inflation, and a ceiling on his salary because of a government wage restraint program. His options for extra income include part-time work with a second employer, or obtaining a better-paying job, or a combination of the two options. The family's major expense obligation is payment on a mortgage (up for renewal) on their house; this they do not particularly want to sell, since they feel their young children should have a house in which to grow up. Mrs. Smith is, however, willing to re-enter the work force in a public relations capacity to help meet her family's financial obligations.

The scenario in the case study shows the Smith's turning to a firm of financial consultant's for advice. As it happens, these consultants have access to and expertise in using a DSS language. The developers of this system, incidentally, take on the roles of the management consultants who are consulted by the Smiths.

The project developers in real-life are respectively Mr. A, an accountant with a strong EDP background, and Mr. B, a research laboratory administrator with very little EDP exposure. While they indicate that in their opinion this DSS model is a simple one in terms of technical complexity, they argue that the questions posed and alternatives examined are of crucial interest to the Smith family, or any other group in a similar situation. The model does not make any decisions for them, but it supports their evaluation by alternatives with pertinent data.

For example, given a level of family expenses, the model determined what Mr. Smith's gross salary (pre-tax) would have to be to meet his obligations. The conclusion was that such a salary level would not be attainable from a single employer; part-time work with a second employer would also not supplement his income to the required level. Mrs. Smith's re-entry into the workforce would be accompanied by a variety of work and home related expenses such as wardrobe, transportation and child-care. There would be also a number of financial planning options available for reducing or deferring taxes which would produce a positive cash flow for the Smith family. Some of the extra cash would be pooled to pre-pay their mortgage; with a reduced payment on their house, their financial obligations could be reduced in five years to allow Mrs. Smith the option of not working, or Mr. Smith to reduce his hours of



part-time employment.

The output of this DSS model are a cash flow and an income statement over a five-year horizon, including the derivation of income levels to produce a balanced cash flow position.

The general form of the model is applicable for communicating to new DSS users the essential attributes of a DSS model. With the appropriate changes in interpretation of income tax regulations, the model could be modified to reflect corporate situations such as introduction of a new product or opening a new plant facility. Of course, the use of a managerial tool such as DSS for management of personal affairs is in itself a creative use of available technology.

PROJECT 2: A Company in Insolvency

A manager in a large accounting firm, Mr. CC, was asked by a bank to analyze the financial health of a company experiencing considerable difficulties. In developing this DSS, Mr. CC addressed the business problem of projecting the company's cash flow for the next twelve months in order to determine the effect on the company's bank loan, and to compare the bank loan to the Company's assets provided as security in order to determine the level of margin coverage. As Mr. CC puts it, "our involvement on behalf of the bank is usually because the financial information available from the company is confusing, late or insufficient in both quantity and quality."

In normal circumstances, the process of comparing changes in a company's cost of sales and interest rates is laborious and cannot be done efficiently and quickly within a limited budget. Consequently, "we must utilize broader mathematical calculations to examine the effects of the change. This limitation is quite serious."

The main outputs of this DSS model are four reports: security and margin coverage, cash flow statement, income statement,

and balance sheet. These reports are interrelated as they reflect the interaction between changes in cost of sales, the bank's security margin, interest rates and cash flow. In addition, the model provides additional reports for analysis of sales, cost of sales and expenses.

Mr. CC notes that "as an outside observer of the company, I could not begin to understand all of the interrelationships. Despite these limitations, the model produced additional information in a form and manner so that the bank and the company could make better decisions."

The company being analyzed has a manufacturing plant, which is rather out of date in a technological sense. It undertook to build new facilities at another location; the recent opening of this plant will likely result in the closing of the older plant. The industries which are the largest customers for this company's products are themselves caught in an economic recession, and are unable to assist by continuing to purchase for inventory. As a result, finished goods inventories are "much too high" and the company is bearing increased inventory carrying costs.

The company's strategies for recovery include expansion into foreign markets, and to raise prices to increase its profit margins. These strategies were modelled in the project, and

the output identified the ranges of increase in sales which combined with increased prices or decrease in cost of sales would return the company to an acceptable profit level from the bank's perspective. By performing a variety of sensitivity analyses, it was determined that the bank's security would be only marginally affected by changes in interest rates. However, if the company was unable to meet its sales and profit margin goals, the bank would be forced to appoint a receiver-manager to recover its security.

In this project, the model identified several areas of operational and financial sensitivity. Since data on company market share was out of date, and no formal business plans existed, Mr. CC was forced to rely on sensitivity analyses to identify critical ranges of values for key variables. In his report on the company, Mr. CC stressed the need to generate monthly statistics on these key variables, and incorporate them in a rolling twelve month projection of cash flows, sales and expenses. This would then be followed by an examination of marketing and sales practices. Mr. CC also recommended that the company utilize a DSS approach in monitoring the sensitive variables beyond what is developed in this model. As he notes, "in times of crisis, it is of extreme importance to gather as much pertinent information as possible in order to develop strategies to combat these problems, and action plans for the short-term and long term."

Mr. CC also notes the general need for such a model in his work with other clients. He feels he has developed a very marketable product, although he recognizes that his own firm's credibility and reputation are a necessary pre-requisite for the use and acceptance of the DSS approach by clients.

As to the model development process, Mr. CC credits the need to state interrelationships explicitly in the model as a strong reason for his examination of specific areas of company operation. Similarly, the requirements for input data for the model identified areas in the company where the record-keeping had to be considerably improved.

Mr. CC was able to identify several areas where the model could be extended. Sales trends, analysis and cost of sales and expenses, inventory, purchasing and costing, and analysis of market demand by customers and products reflect some of his suggestions. "By examining these additional components in a DSS model, the company's management would understand its basic operations and capabilities. However, this examination must be done by the company's management, not by consultants such as ourselves."

PROJECT 3: An Inventory Problem

The business problem addressed in this DSS is one faced by a distributor of laboratory equipment supplies in coordinating its inventory control and purchasing operations. The purpose of this model was to identify the purchase volumes that would satisfy the requirements of economic order quantities, be consistent with forecasted sales volumes, and also achieve a desired turnover rate.

This DSS problem was identified by Ms. E, a senior manager at the above firm. Ms. E is in her early thirties, has a technological background but is not too familiar with computer systems. Simultaneous to undertaking this model development, she was given additional responsibilities at her firm in the areas of sales and finance; both areas were unfamiliar with respect to her past managerial experience, encompassing about ten years in the same industry.

She was teamed up with Mr. F, a consulting engineer with supervisory responsibilities. He has had previous experience with computer systems, and presently supervises the use of

computer systems on client projects. This model appealed to him as a challenging exercise.

Based on Ms. E's write-up of the problem, Mr. F was able to develop the necessary equations and the relationships between the variables. Ms. E concentrated on developing the data required by this model. As she recalls, just the process of assembling the raw data gave her "tremendous insights" into her new managerial responsibilities at work. To keep the model to reasonable limits of coding, she converted the statistics for many hundreds of individual products to a few categories of dollar amounts. This simple aggregation shed new light on the extent of her company's dealings with individual vendors by product lines. The company has been linked to various vendor computer systems for order entry purposes, but has had no detailed statistics for individual product lines. This new-found information was quickly put to productive use by Ms. E as part of her new managerial duties.

Mr. F linked his company's dial-up terminal to the university computer to use the DSS language and was able to experiment with a variety of language features and options. By a process of trial and error in developing small (but unrelated) models, he acquired a basic knowledge of the DSS language. At this stage, he began to discover the "user friendly" nature of the system; the reference manual and the system error messages and

prompts all started to facilitate his discovery of the power of the DSS.

Ms. E's relationship with the system was not so easily established. She discovered that information entered at a terminal keyboard in lower case letters were treated differently by the system than if it had been entered as upper case. The number zero (0) and the letter 'O' looked sufficiently alike to her that she substituted one for the other in model input, and wondered why the system flagged her input with strange error messages for undefined variables. Even entering multiple lines of data rapidly on the terminal keyboard without looking at the screen monitor for error messages caused frustrating delays through being required to re-enter the data.

Overall, this project moved along quite smoothly. Mr. F's forays into examining system options caused the allotted project budget for computer resources to be overrun, but the project was still completed ahead of deadline.

One consequence of the early finish was that they did not experience any degradation of system response. Other project teams trying to meet the end of term deadlines found themselves waiting for over ten minutes between keying in input commands, as they competed for computer processing capacity.



The model input consisted of data made available from Ms. E's company, and "rules of thumb" relationships between key variables. The data had to be "massaged" into the form required by the model, and this exercise was unfamiliar to Ms. E and her staff. However, once the procedure was debugged, this was taken over as part of routine clerical functions.

The output of the model was in the form of a number of cash flow and income statement reports, corresponding to sensitivity analyses for a number of variables. Mr. F's enthusiastic exploration of language features of the DSS resulted in a variety of graphs and plots being generated; however, it is difficult to estimate the usefulness of this part of the output. Possibly the most critical report was one that consolidated statistics across a number of product lines, corresponding to the various corporate strategies pursued on diversification.

Mr. F's acknowledged abilities as an intermediary were quite evident in the successful development of this project. Ms. E, commenting on her post-project computer work notes: "It all looked so obvious and logical when Mr. F responded to all those system requests and error messages, but you quickly forget what to do when you have been away from the system for a while." The combination of a manager and a qualified

intermediary proved to be an impressive team for this DSS project.

It is perhaps more significant to note that Ms. E approached her next DSS problem with a much greater level of confidence, albeit with a certain amount of apprehension of going it alone.

PROJECT 4: A Corporate Budgeting Model

This project was undertaken to develop a corporate financial model for a regional chain of "home centre" stores for use in their budgeting process. The model was developed by Mr. G, a senior executive of this corporation with a long and intimate knowledge of its operations. He was teamed up with Mr. H, a planning engineer of considerable experience in design concepts. Neither of these two individuals have had much prior exposure to the areas of MIS or model building.

The present budgeting and forecasting process at this company is a manual one. Notes Mr. G: "in order to change one item on a statement, it requires an accountant to spend 2-3 days in reworking all the numbers in the budget." The consequences of this manual process are that the firm does not attempt to project too many scenarios in its budgeting exercise.

The model parallels the company's annual budget, and makes extensive use of heuristics based on Mr. G's knowledge of company performance and operating leverages. Key variables include different components; for example, "sales" is made up of "cash sales" and "charged sales". Similar breakdowns are

incorporated for costs as wages, semi-variable, fixed operating and fixed overhead. Other key variables include interest rates, inventory, purchases and bank loans.

Examples of heuristics include fixed ratios for sales to advertising, gross margin to sales, wages costs to sales, rates of inventory turnover and semi-variable costs. These ratios are tested for their significance of effect on net profit-after-taxes via sensitivity analyses. Other variables on which sensitivity analyses are performed are cash sales as a percentage of total sales, and the interest rate. If the changes in cash flow are significantly affected by a change in the percentage of cash sales, then cash sales can be increased by modification of credit policies, method of advertising, hours of opening, inventory levels and services provided. The significance of the interest rate is in that the company's financing is presently based on the prime rate; any change here would directly impact the cash flow picture.

Input data for the model consists of four previous periods of information to allow forecasting of accounts receivables and purchases. All inventory, purchases and sales are measured in dollars. The output consists of an operating income forecast and a cash flow forecast, by month. In explaining the use of sensitivity analyses in the model, Mr. G noted that he posed questions that would make sense to managers of the company.

"One example would be that if you raise your advertising amounts, you are apt to cause a shift towards higher cash sales. Another example would be that if you lowered your gross margin, you would probably raise your inventory turnover rate, i.e., buy more often and experience greater sales."

This model is now an integral part of the company's budgeting process, and represents a fairly comprehensive package. One of the benefits from this modelling effort was that Mr. G was able to derive ratios between other pairs of key variables to add to his considerable arsenal of performance heuristics.

PROJECT 5: New Product Introduction

This project involved the development of a DSS to investigate the risks involved in bringing a new product (referred to as an "electronic gadget") to the marketplace. Only one person, Mr. I, was involved in this DSS development. He is an individual with a strong background in engineering and computer science, and functions as a consulting engineer.

Mr. I's primary concerns in this project were in identifying cash flow requirements, capital investment needs of the project and their associated timing, and the return on investment. He had previously identified uncertainties with respect to expected size of the market in which the "electronic gadget" would compete, and the market share it could expect to obtain. Production and distribution costs were two other major items of concern to him.

The DSS approach was not his first attempt at obtaining the required answers. Using the best single number estimates for his key variables, he had previously developed cash flow projections for his investment. And, he noted, "the answers looked positive and good."

The DSS approach, however, allowed him to test the risks associated with the project. By developing probability distributions for his market share and size variables, he ran simulations of his cash flow model. As well, he was able to check the sensitivity of his parameter values through a series of "WHAT IF" questions.

Instead of the evolutionary approach to DSS development discussed in the literature, he used a conventional MIS approach to systems development. He already knew what tests of risk analysis and sensitivity analysis he wanted to perform, and in retrospect considers this phase of development "a routine business". He completed the coding of a model with 50-60 statements during the course of one evening; the final version of his model was very similar to the initial attempt. It was an ambitious effort in that this was the first model he had developed in this particular DSS language. On being asked if and how he had made use of the reference manuals for the DSS language, he remembered scrutinizing how particular problems had been coded. He did this in order to better understand the overall approach taken to resolve them, rather than undertaking a close examination of the individual DSS language commands and syntax. This strategy perhaps may neither occur nor appeal to large numbers of managers tackling an unfamiliar DSS language; it is, however, consistent

with Mr. I's previous extensive exposure to computers and reading of associated reference manuals.

The customized report-writing features of the DSS language were almost completely ignored in favour of using system "default" options. Mr. I explained that he wasn't interested in the output presentation aspects of the model, since firstly it was for his own use, and secondly he knew "what I was looking for."

He had most of the data for his model readily available from his previous cash flow model based on "best estimates"; additional values were developed for probability distributions etc. with little difficulty. In effect, Mr. I used this DSS as a "number-cruncher", and found the experience as he recalls, "mind blowing beautiful." Sessions on the interactive computer terminal at 3 a.m. allowed uninterrupted dialogue between system and developer, and may in part account for such a positive reminiscence.

One consequence of the large number of iterations in his simulation model was the rapid exhaustion of budgeted computer time. For managers planning to use these sophisticated DSS commands, he warns of the need to carefully monitor DSS-related expenditures, as "the budget gets chewed up very quickly."



The DSS model results did shed some new light on the problem of introducing the "electronic gadget". While the previous model had produced a positive return on investment, now the production costs emerged as the most critical variable in determining product profitability. This meant that the production process had to be analyzed in greater detail. This result was regarded as a major contribution of the DSS project in that it identified a flaw in the planning assumptions which might have otherwise gone unnoticed. As a postscript, it is noted that Mr. I's firm of consultants makes extensive use of computer models (some of which qualify as DSSs) on projects for their clients. This is not the case for management of their own business. A possible reason; "anything that challenges the autocratic management process, and a DSS would, could not be tolerated."

Mr. I commented: "the capabilities of the DSS language allowed me to consider analytical options that I would not have normally considered. Actually using these options provided considerable insight into the problem."

PROJECT 6: A Model for Human Resources Planning

This project undertook to develop a model of the utilization of human resources at a university. The developer, Mr. J, was a recent entrant into the Personnel department of the university, and required an analysis of the composition of the organization's human resources for purposes of forecasting trends and bottlenecks.

The major contribution of the project was in locating and organizing the data which permitted the required analysis. Using one staff group, namely the administrative and professional group, as a prototype, the model summarized statistics for the previous five years by a number of characteristics. Such variables as age, sex, salary, grade and length of services were considered for turnover and survival rates, etc. The trends established by this analysis were projected to assess the potential consequences for the university, using current turnover and survival rates.

Although the university has, for a number of years, used a computerized system for monitoring payroll and personnel information, data required for this model was also obtained

from a variety of manual records. This aspect of pre-DSS development has been noted in the literature as an incentive to the building of the model itself. One additional feature of this project was in its use of multi-colour graphs and plots of the data to visually highlight the patterns of change in individual data categories which might otherwise have been overlooked.

Following the successful development of the basic model using data for one prototype staff group, the developer continued to expand it to include the other groups employed by the university. Some of the implications for personnel management highlighted by the DSS model are worth noting. For example, projection of current trends indicates an increase in the number of staff with the same cost in salaries; i.e., fewer senior managers and more junior personnel. Another trend (for another classification) indicates a primarily female workforce in a unionized collective bargaining unit. The results of a recent work stoppage and strike in terms of turnover rate were also very evident from one analysis in the models. In yet another classification, projections indicate a large number of employees entering retirement age at approximately the same time, a possible source of concern.

While this model is primarily oriented to the analysis of data devised from a variety of sources, its power lies in allowing

Mr. J his managerial evaluation of a variety of scenarios and in retrospective analysis of previously unclear events.

PROJECT 7: Real Estate Investment Analysis

The objective of this DSS model was to evaluate a real-estate investment on a limited partnership basis. A large apartment building was purchased at the height of real-estate fever at a very high price. However, the building was well-situated, close to a shopping centre and a proposed light rapid-transit stop. The rents in the area were low, so that a government imposed restraint on rent increases did not seem to be an insurmountable problem. Also, a modest capital appreciation in the equity of the limited partnership seemed a reasonable expectation.

A preliminary cash-flow analysis prepared manually by Mr. K, the developer of this DSS, indicated a negative cash flow over the short term but annual rent increases were expected to rectify this situation. With the DSS model, Mr. K hoped to predict a break-even on cash flow and growth in partner equity.

The output of this model was a calculation of actual revenues and expenses for the first year, and then using certain assumptions, a pro forma income statement and balance sheet

for the next five years. The inputs to the model were obtained with the assistance of the accountant for the investment project.

The sensitivity analyses examined the effect of different apartment vacancy rates, changes in timing and interest rates for refinancing second mortgages (within the five year planning horizon), and expected appreciation of capital value of the building.

The scope of this DSS is quite modest in comparison with other DSS projects reviewed in this study. But as Mr. K notes, "my prior exposure to computers was limited. In tackling this DSS project, I purposely took one I thought I could handle readily. It is, however, one which has much personal meaning to me."

PROJECT 8: Staffing of Customer Service Functions

The objective of this DSS was to assist in evaluating staffing requirements in the customer service department of a major department store. Mr. L. who is the manager of this department developed this model to balance payroll expenses against average service time (i.e. waiting time and processing time) per customer. Mr. L's department is composed of two sections. The first section is responsible for answering incoming phone inquiries. Simpler inquiries are quickly researched and answered for the customer on-line, while the more difficult inquiries are "written up" for completion by the second section which responds to mailed inquiries. Management objectives for the telephone answering section are to keep the expected waiting time to less than one minute per customer; the average time to resolve an inquiry is five minutes. Time pressures are less severe in the mail inquiry section; generally, two to three days are available to complete the research on these inquiries.

Day to day fluctuations in number of telephone inquiries can be significant, and adds complexity to assembling a realistic payroll and staff budget. Another factor is the number of inquiries which must be carried over to the next working day. If the number is too low, the office basically has to wait for information from other departments. If the number is too high, the staff becomes discouraged.

The DSS model developed a budget for the two sections of department over a four-week planning horizon. It also performed a range of sensitivity analyses on the level of mail inquiries and incoming phone calls; these were represented as normally distributed parameters.

The model output consisted of a Monte Carlo simulation and produced estimates of number of inquiries, total staff level, average work carryover and total payroll amounts for each of the four time periods included in the budget. For sensitivity analyses, changes in these parameter values were expressed as a percentage of the "base" case.

Using operational data from the previous year, Mr. L. found that mail inquiry and incoming phone call levels had a much greater impact on the levels of average carryover than he originally expected.



"Probably the greatest surprise for me in using this model was in conjunction with the "WHAT IF" feature on the upper limit specified for carryover of complaints. This figure has a very visible effect on the morale in my office. It seemed intuitive that it would be much more costly in payroll terms to keep our carryover low, rather than to let it rise. Yet the model shows no such effect. In fact, it seemed to demonstrate that the costs are very comparable whether our carryover is high or low. This can perhaps be explained by realizing that it will cost us approximately the same money to answer a particular number of enquiries, whether we answer them right away or later. Enlightening!"

PROJECT 9: Manpower Planning

The processing of certain types of insurance claims in Canada is a government responsibility. Typically, an applicant for insurance benefits files a claim at a local insurance office, and deals with an "Agent 1" person for the initial assessment of the claim. If the application is in order, an Agent 1 can process it to completion. Claims requiring adjudication are passed on to an "Agent 2" person for further handling.

The staffing allocation for Agent 1 and Agent 2 personnel for an insurance office is based on an annual estimate of future claims and forecasted by a group at regional headquarters using regression analysis and econometric modelling techniques. The forecasting models have worked well in the past. At the beginning of each fiscal year, a certain number of person-months are allocated to each office, and the manager must then operate within his budgeted resources. He can allocate these resources in a flexible manner (to deal with seasonal fluctuations in the claim load, for example), but must not have overspent his budget at year-end.

However, in a period of economic downturn with an accompanying increase in unemployment, an insurance office manager does not have access to any tools to help him quickly determine an appropriate response to increased workload. The manager can deal with this problem by working his staff on an overtime basis, hire and train additional staff, or divert personnel from other insurance offices.

The decision to build a DSS was based on the very real need to examine the effects of the increased claim load on insurance operations. One of the developers of this DSS, Ms. M, was a manager of an insurance office faced with this problem. She notes: "when forecasts for the 1982/83 workload were determined, the depth of the current recession was not foreseen, and as a result, the workload and staffing volumes projected were, to say the least, conservative. Since the budgeting process began, the economic picture has changed (for the worse) dramatically, and for planning purposes, it is useful to know the impact of these changes on the staffing requirements." Faced with a large backlog of claims waiting to be processed, she expected to use the DSS model to estimate (and therefore allow her to justify) the additional resources required to staff her operations.

Ms. M has been in her present middle management position for a short time, but has between 5-10 years of experience in her

ministry. An Arts major, she has acquired most of her knowledge of computer systems and modelling in the MBA program, Computer terminals located at her branch office are used for transmission of operational data to national headquarters; no programming or inquiries to any databases have been undertaken at the branch office level.

For this DSS project, she was teamed with Mr. N, a senior manager for a firm specializing in manufacturing engineered products. With a technological background and over ten years of management experience, he too has acquired most of his OR/MIS knowledge in the MBA program. Both Ms. M and Mr. N exhibit a positive attitude to the use of computers for managerial decision-making.

The project was initiated by Ms. M with a written outline of the problem. This served two purposes; firstly, it identified the boundaries of her overall problem to be tackled within the DSS, and it helped Mr. N understand the objectives of the exercise.

Mr. N used the descriptive problem statement to develop a list of the parameters involved, as well as their interrelationships. He notes: "once consensus was reached (with Ms. M) and the parameters established, there was no further problem." Ms. M is more appreciative of Mr. N's efforts at

this stage: "If he hadn't outlined the logic, I doubt if I could have continued."

Coding the model in the DSS language did not prove to be a major problem. Also, the required data was readily available from Ms. M's office records. The logic of the model incorporated the work standards for the Agent 1 and Agent 2 functions involved. These work standards had been previously developed by national headquarters staff on the basis of time and motion studies, and were generally considered as valid for budgeting purposes. The model also allowed for non-productive time such as disruptions in regular routine, in addition for vacations, sick leave etc. Averages of pertinent data for previous years were used to determine these figures.

The 'debugging' of the model proceeded as a sustained effort, impeded by unfamiliarity with terminal operation and error messages from the DSS system. These problems were fortunately resolved through the timely assistance of another MBA classmate who was more intimately familiar with resolving these situations. Here we have an information transfer specialist, acting (informally) in a technical assistance role; nevertheless, his assistance was greatly appreciated by the project team. Asked if the DSS system was "user friendly", they felt it was so only after they had acquired sufficient familiarity

with using the system. Their initial experience in dealing with error messages was quite frustrating.

Ms. M was quite enthusiastic at this stage that "the model would show my office was understaffed." Contrary to her expectations, the model indicated that her office was actually overstaffed in both Agent 1 and Agent 2 categories. It had previously been asserted by the national headquarters staff that backlogs in claims processing were the result of poor productivity on the part of branch office personnel. This was an explanation which Ms. M was not prepared to accept in view of her personal knowledge of her operations; she therefore attempted to seek answers by identifying other factors which could explain the variance in the results. She noted that her office had experienced a high turnover in staff, which meant that time had to be allowed to train replacements to become fully effective in their jobs. She hypothesized that the work standards had not been developed with such a mix of experienced and new staff in mind; so Mr. N made a change in the model for an additional allowance for unproductive time.

Still the model results indicated a significant overstaffing condition in her office. Did the job structure make a difference, she wondered. After all, people don't do the same job for the whole day. At this stage, she became curious about the components of the work standards included by

national headquarters for the Agent 1 and Agent 2 categories. She discovered that there were in fact quite a number of standards corresponding to specific components of each job.

To her greater surprise, some of these work standards were based on job components for which her office was not required to and did not maintain any records. As she noted, "the branch office does not keep track of items included in the work standards, yet the budgeting is based on them. My people are being measured on items that we do not keep track of."

In attempting to pursue the issue of verifying these work standards, she noticed a distinct lack of interest among specialists in her local region. Was it a case of not wanting to open the proverbial "can of worms" with national headquarters? The project was brought to a close after undertaking a variety of sensitivity analyses for different volumes of claims and processing times; it was also close to the end of term.

Ms. M continues to be enthusiastic about using the model for estimating staff and overtime requirements corresponding to work standards based on actual historical experience in her office. She is hopeful that the model structure will easily allow modifications to be incorporated. Mr. N has the last word on the use of DSSs in his own environment: "We would use

a DSS if it were available. Otherwise people end up making political decisions, or piecemeal decisions."

Both of the model developers deemed the project a modest success even though the results were not what they had expected. They were impressed with the ability of the DSS to handle "soft" data in the form of forecasts and estimates, and in being able to combine their different ways of problem solving in an effective manner.



PROJECT 10: Group Life Insurance Plan Evaluation

The primary objective of this DSS was to assist an insurance agent in making recommendations to a client for selection of one of a variety of group insurance plans. Two variables were considered significant: the benefits offered by the insurer, and the corresponding rate structure. Even though a client may require certain specific terms and benefits, various insurance companies may at times be unable or unwilling to comply with these requests; also, they may choose either not to quote at all, or quote on a different basis from that required by the client. Lower rates do not necessarily correspond to lesser benefits, but this is not always easy for the client to readily identify, since the wording and terms of the benefits are not directly comparable. Hence the role of the insurance agent is central to this evaluation process of matching client needs to available plans.

The first group of benefits considered for the DSS model included life insurance (L.I.) and accidental death and dismemberment (AD&D). A client company could request coverage in either category as some multiple of employee salary or a flat

amount across the board, or different coverages for blue collar workers, white collar workers and executives. Rates quoted for this benefit could be different for one insurance company if the annual salary for certain employee groups had exceeded the amount the insurance company was willing to underwrite without medical evidence of insurability.

The second group of benefits included Extended Health Benefits (E.H.B.), Weekly Indemnity (W.I.) Long Term Disability (L.T.D.) and Dental Plans. Here too, different insurance companies would set their rates depending on their terms.

For example, the waiting period before an employee collects weekly indemnity benefits due to accident could vary in different plans from one day to thirty days or longer. The rate charged for this benefit would decrease as the waiting period was extended; however, not all companies would charge the same rates or offer the same terms. Also, each company uses its own "experience" in claims paid. Similarly, the length of time this benefit is paid and the maximum amounts insurable are other considerations. On other benefits, while premiums paid by employees are not tax deductible, any resulting claims are tax-free. If premiums are paid by a company in part or in whole, resulting claims are deemed taxable benefits.

One criteria for the model design was that it would be able to compare individual insurance company programs and benefits in qualitative terms (e.g. by use of weighting factors), so that a client might have another measure of comparison besides price. Such a DSS was felt to be readily marketable to other insurance brokers; presently this problem is tackled on a manual basis.

The developer of this DSS is Ms. O, an insurance broker with the highest professional credentials. The above statement of the DSS objectives is a reflection of her intimate familiarity with the operating environment. She had no direct involvement with computers prior to entering the MBA program. Her company's efforts over the past two years to computerize agent compensation plans are still in the shakedown phase, and have left her with a negative attitude towards computerized information systems. "EDP development in my company has been a drawback to me. We are not even doing as well as we did manually. For example, agents are supposed to get their commissions twice a month, and up to now it is being done manually, once a month."

Her objectives in developing this DSS were to make client presentations (or comparison of group insurance plans) more orderly, in being able to compare a larger set of alternative

plans, and in allowing clients to use multiple decision criteria in evaluating their requirements.

While the amount of instruction she received on the DSS language and the terminal operations was about the same as everyone else in her MBA class, her reactions to "unresponsive" operating systems, "undecipherable" error messages and "not so obvious" terminal operating procedures were quite pronounced. "I am not the greatest diplomat in the world", she admits.

She received considerable assistance from one member of her class, who had acquired some familiarity with the DSS language and terminal operations. "Without him, I'd still be working on the project." On closer questioning as to what he actually did, she says "well, he got me out of things that were happening - with terminal messages, showing what to punch and what to do - at that time, it was really invaluable." It is worth speculating what her responses were to similar occurrences when this "good samaritan" was not around to help.

A combination of high expectations and unfavourable experiences has served to confirm her negative attitude towards computer systems in general and DSSs in particular. If implementation is indeed the management of expectations, as is

noted in the literature, it was not executed particularly well on this project. "As an experience, it was most frustrating -- a missed opportunity."

And yet, the model was coded in the DSS language, and the data entered; an impressive looking output report was produced. But she was not at all impressed, even though this was her first ever effort at developing a computer program. "It took me as long to enter the data as it would have taken to solve the problem manually." As to the impressive looking output, it "was a mechanization of the presentation formats" she had previously done by hand. She shrugs off a suggestion that she has eliminated possible calculation errors and counters that a DSS should do more than be a "hot pencil", referring to the basic calculations and the sensitivity analyses performed within the model.

In comparing the problem statement with the model output, it quickly becomes obvious that the weighting of qualitative factors, e.g. in comparing one benefit package to another has yet to be included. The DSS literature makes much of the ability to incorporate subjective and judgmental input into DSS models, but it does not say how it should be done. So it is not surprising that she asks: "what values or weights should be assigned to the qualitative variables? It could be

that each client assigns different weights to them. It is fairly obvious that the more expensive benefits should have bigger weights, but how much?" It is difficult not to sympathize with her in this predicament. Perhaps timely access to a qualified information transfer specialist would have allowed her to resolve this concern. This situation, at any rate, illustrates one of the hazards of managers developing their own DSSs, even if the systems are labelled "user friendly." Her final comment on the model output: "the results have meaning but no value" - where did we hear that before? Is DSS another name for MIS?

PROJECT 11: School District Enrollment Forecasting

School district administrators rely on forecasts of school populations as a fundamental aspect of their short and long range planning activities. These forecasts are used as a basis for predicting facilities and staffing requirements, and the maintenance of regular and specialty program offerings. Over the last decade, declining enrollments have forced administrators to consider the possibility of closing or consolidating schools. Thus the accuracy of school population forecasts has become a critical issue for school administrators.

School enrollment projections are prepared annually for each district by the Ministry of Education using forecasting techniques which rely on past trends. While these estimates have been reasonably accurate in the past with a 2-8 percent margin of error, the issue of school closures has focussed on the need to explicitly consider issues, assumptions or changes at the local district level. Since most decisions and plans must be gradually phased into the school system, a DSS at the local school district level was felt to be warranted.

One critical variable in the DSS model is the retention factor, i.e. percentage of students moving up from one grade to the next. The model assumes that past trends in retention factors will continue over forecasted periods. For kindergarten students, the retention factor is calculated as the ratio of kindergarten enrollment to number of births five years ago; for grade one students, the ratio used is grade one enrollment to number of births six years ago.

Inputs to the model consist of actual births and enrollments in kindergarten to grade twelve for the past fifteen years. The output consists of projections of births, retention factors between births and kindergarten and grade one (five and six years ahead, respectively), and retention factors between other grades on a year to year basis. Projections were attempted using linear as well as quadratic functions.

The developers of this DSS were Ms. P, a home economics teacher in the school district for which the data was input, and Mr. R, an engineer in a consulting company. Ms. P had little or no previous experience with computer systems, whereas Mr. R had an extensive background in the design and programming of information systems. Mr. R felt the DSS language to be of limited value for his work environment, and normally did his own programming as required. Ms. P expressed the feeling of being somewhat overwhelmed by actually



developing her own model. The division of labour was very clear cut; Mr. R handled all the technical aspects of terminal operation and system access; Ms. P attended to all problem-related matters such as data collection and entry, and validating the model output.

The usefulness of this model was diminished by the fact that neither Ms. P nor Mr. R were the prime user of the results. The school administrators who had provided the initial data and specifications for the model were unable to validate the output. Their initial enthusiasm faded into indifference, and the DSS project essentially fizzled out. The end of term project deadline brought this effort to a welcome termination.

PROJECT 12: A Merchandise Budgeting System

As Sales and Planning manager for a chain of retail merchandisers, one of Ms. Q's tasks is to prepare a semi-annual merchandising budget. These budgets, based on financial objectives must be integrated with appropriate merchandising strategies, and are considered an essential tool for effective management of retail organizations.

The starting point of a merchandise budget is the determination of a sales figure; this figure is influenced by the expected performance of existing store operations and new stores in development, specific promotional campaigns as well as corporate profit objectives. Agreement on this figure is reached through discussions among merchandising, operations and financial management, and a resulting gross-profit figure is calculated. Linking the sales and gross profits are a number of factors, including markdown rate, inventory levels, and markup rate. These factors are set by intuition and heuristics, and their effect on gross profit is not known until a detailed calculation is made.

At the operational level, these factors are under the control of the merchandise buyer through establishment of purchasing and inventory levels, and pricing (including price reductions) and promotional programs. The buyer thus exercises control over ultimate gross profit levels. Under current budgeting procedures, when a buyer receives a directive to increase markup by a certain percentage, the corporation is unable to quickly assess the impact of this directive on gross profits, particularly to determine if it is consistent with corporate objectives. Ms. Q admits that "presently we attempt to achieve this balance by trial and error, and doing it manually is a slow process."

For this project, Ms. Q was partnered by Mr. S, a consulting engineer. One of the objectives in developing this DSS model was to facilitate speeding up the negotiating process between corporate executives to arrive at a figure for expected sales, by ensuring that individual buyer objectives matched corporate goals. Related benefits included fast and accurate computation of results, the ability to perform sensitivity analyses on key variables in the decision process, and consolidation of results across multiple departments in the merchandising function.

Input to the model consists of historical data for sales, opening inventory, markup and markdown rates, and dollar

levels of purchases. Current estimates for these factors are also input (as percentages) to indicate the degree of improvement or deterioration implied in the current budget.

Calculations for each department in the merchandising function utilize the same mathematical format. All output is uniform in presentation for each department, and is summed to produce a consolidated report. Sensitivity analysis on sales targets can be used to calculate corresponding gross profit levels and acts as a test of consistency between the objectives for these variables. Although each department's plan may be individually modified, the cumulative effect is reflected in the consolidated statement report.

The goal seeking feature of the DSS language was used to derive sales targets (normally an input) from a target gross profit dollar figure (normally an output). Ms. Q notes that this approach was selected since the overall gross profit is viewed as the ultimate goal. "One advantage of goal-seeking is the fact that it could lead to procedural changes in the budgeting system. Provided that everyone is in agreement on the targeted gross profit, and that all other factors are approved, the determination of sales could become the last step rather than the first."

Over the course of this project, Ms. Q became aware that the initial set up of the DSS model would require more time than following the established manual procedure. She agrees, however, that once the model is operationalized, the benefits would far outweigh those of the present system.

PROJECT 13: Analysis of Corporate Overheads

Mr. T is the chief financial officer for a firm providing engineering and architectural services. At the time this project was undertaken, Mr. T notes: "analysis of operations was skimpy, basically consisting of deriving net profit as a percentage of total revenues".

The problem investigated here is related to the way engineering and architectural firms charge their clients. The charges are based on a "multiplier" of engineering salaries directly charged to projects. Other direct project costs such as computer services, telephone charges, drawings and reports, etc. are charged at cost. The "multiplier" applied to the hourly engineering salary dollars varies according to the profit objectives set and the overhead costs incurred by a firm. The overhead includes expenses for insurance, rent, depreciation, administration, etc., and is generally expressed as a percentage of engineering salaries. The calculation of the multiplier is easily expressed by the formula:

$$\text{Multiplier Value} = \frac{\left(1 + \frac{\text{Overhead Costs}}{\text{Engineering Salaries}}\right)}{\left(1 - \frac{\text{Net Profit before Taxes}}{\text{Revenue}}\right)}$$

Thus if the ratio of overhead to engineering salaries is calculated as 0.5, and the desired profit to revenue ratio is .40, the equivalent multiplier is  $(1+.5)/(1-.4) = 2.5$ . Hours charged for engineering services to a client project are costed out at 2.5 times the engineering salaries.

The value of the multiplier used for any project is constrained by the competition from other consulting firms. A firm cannot consistently charge a multiplier of say 2.50 when its major competitors charge a multiplier of say 2.10. But, notes Mr. T, "there is enough leeway for our firm to vary its multiplier according to the situation encountered".

The basic model is made up of the budgeted overhead costs and the percentage of these costs are of expected productive salaries. The productive salaries are computed using average salaries times the number of people in the firm working on "charge-out" projects. The number of people is determined of course by the revenues anticipated for the year.

The overhead costs are summarized in four groups: employee benefits, sales promotion, occupancy costs, and administrative expenses. Within each of these groups, selected expenses are broken down when they are significant. For example, employee benefits represent expenses for pension plan, unemployment insurance, medical plan, vacation and sick pay categories.

Similar breakdowns are undertaken for the other groups. After all the overhead costs are added, "overhead percentage" is calculated as a percentage of productive engineering salaries.

The outputs of the model may be viewed as establishing heuristics, i.e. rules of thumb, by indicating the variation in the "overhead percentage" which results from varying selected components of the overhead cost variable. For example, the model shows that a 10 percent change in any of the selected components from sales expenses, administrative salaries, rent and professional liability insurance causes no more than a 1.2 percent change in the overhead percentage. This indicates to Mr. T the degree of flexibility he has in manipulating these selected cost components without jeopardizing the corporate profit objectives. If a large increase in sales promotion is expected to yield significant additional revenues, then it would be beneficial to increase the sales promotion budget. On the other hand, administrative salaries must be kept to within the 10 percent range to keep the overhead percentage within acceptable limits. The model also indicated that a 10 percent increase in productive salaries would bring the overhead percentage down by only 4 percent, i.e. only a modest level of scale economy is present in the organization.



Other analyses carried out by the model dealt with the effect of taking on a large project in the short term, to be executed in addition to preplanned activities. The significant elements are in the nature of additional chargeable salaries, and project overheads incurred because of the "short notice". The overhead percentage declined by a modest amount.

Mr. T evaluates this DSS exercise as being "quite simple", but believes this could be the basis for extending the budget process into a 3-to-5 year strategic plan, encompassing corporate expansion, and project feasibility options.

PROJECT 14: Economic Analysis of Land Developmental Projects

This DSS represented Mr. U's first attempt at developing a model to evaluate the economic feasibility of a land development project. Mr. U is a project manager for a land development company; as a qualified architect, he is involved in all aspects of project feasibility studies. The timing of this DSS project coincided with the acquisition of a DSS package by his firm, to run on their interactive computer system. His orientation to the DSS language came through a short introductory training session provided by vendors of the package. Additional assistance was available from computer specialists in the firm.

For this DSS, Mr. U duplicated a problem he had previously tackled manually. Changes made for the DSS model included revised report formats, and a large variety of sensitivity analyses. Variables normally treated as fixed in manual calculations for reasons of economy, were treated as contingencies. For example, selling dates for real estate are normally assumed to be fixed in manual calculations, since otherwise the calculations become overwhelming. But by assuming this to be variable, a number of creative financing options can be evaluated.

Recalling the model development process, Mr. U felt extremely frustrated by the periodic slow response time from the computer system. "There I was sitting at the terminal, for minutes on end, doing nothing but staring at the screen. If I were doing the calculations manually, I could have used the time for other things." Still he was impressed by the streamlining of the calculations made possible by the DSS model. He felt that this would result in more "refined decisions" since it would have the effect of changing the firm's way of thinking about the economic feasibility of projects. The decisions would also tend to become more qualitative from an increased awareness of the significance of key variables and their associated uncertainties.

In an interesting corporate decision, computer specialists from the vendor of the DSS package were retained to develop a "sophisticated and comprehensive" model which could be used in a "black box" mode by project managers.

PROJECT 15: Planning Guide for a Small Business

Ms. V is an independent management consultant specializing in advising small business in financial and other administrative aspects of their operations. She places great emphasis on personal contact with the owners and managers of her client companies, and feels she acquires an intimate knowledge of their business during her association with them. Her relationships with her clients are generally of a long term nature rather than as short term assignments, and she often uses "we" and "us" in referring to a client's business. Her recommendations are thus offered not just in the form of written reports, but also with her considerable personality and conviction.

This project was undertaken as an assignment for a small business client. The company is a small retail stereo equipment outlet in its third year of operations. As Ms. V notes, it was quite profitable during the first two years of operation. It allowed the owner operator to withdraw an average of twenty-five thousand dollars in director's fees.

The previous success of this business was due in part to the very real expertise of the owner gained through many years of experience in the field. This company is his first experience in running his own business. However, the current downturn in the economy has hurt sales considerably. Ms. V has undertaken development of this DSS as a planning guide for the company's future operations.

The design of the model was influenced by her personal style in tackling this assignment. "I built a model that I could use, one that would produce the sort of results I needed. Essentially it was a flexible model designed for a practical application." The outputs from this model were in the form of cash flow reports, and sensitivity analysis on various line items in the income statement. Additional analysis focussed on credit lines, inventory levels and profits, i.e. items of considerable significance to small businesses. All of the reports were inter-related, so that a change in a parameter value affected all relevant reports. In validating the results from the model, Ms. V said she applied normal accounting tests and ratios as she would for manually prepared reports.

While Ms. V was quite enthusiastic about the value of this modelling exercise - "it had a strong carryover effect in identifying gaps in client planning" - she was quite critical

about the technical support and facilities available for model development. Her comments should carry considerable weight in discussions of this aspect of manager-developed DSS's, since she is a leading candidate for this category of developer-user. "For a system to be user friendly, the user must be able to communicate with the system at a certain basic level. To reach this level, there is a strong need for technical support at the early sessions. A manager cannot just sit at a terminal wondering what next to do. Managerial time is too valuable for that. Besides, he might just not return to that terminal again. Yet, once I got to understand the command language for the DSS, things got easier - I gained confidence - I found myself helping others who were not yet at the level I was at ... But don't expect a manager to be told: here's a terminal, here's a reference manual, go to it. You have to somehow get the user to that basic level of competence first. Of course, it is a lot easier the second time around."

This project has a favourable postscript. Ms. V has acquired a portable microcomputer and a compatible DSS using a spreadsheet approach to displaying calculations. She continues to be positively oriented to the use of this tool as an integral support for her consulting assignments.

PROJECT 16: Rate Calculations for a Health and Welfare Trust

Ms. W is the administrator of the Health and Welfare Trust for her company. This Trust serves as an employee benefits insurer for the subsidiaries and divisions of the parent company. Administrative services for payment of claims are contracted out to a "re-insurer". Ms. W's company remits monthly premiums to the Trust, and funds are transferred to the "re-insurer" when claims are paid.

The objective of this DSS was to assist the administrator of the Trust to calculate employee contribution rates for the health and welfare benefits. These rates are based on claims experience, and are recommended to the parent company management for acceptance and implementation.

"The calculations are not particularly complex but are time consuming when done manually, as they usually are, because they must be performed for each division for each benefit. The normal procedure has been to calculate rates based on claims experience for the past twelve months. Manual calculations make it cumbersome to consider a longer history of claims experience."

With this DSS, claims experience for the past eighteen months was used to calculate a new rates structure. Using the sensitivity analysis, i.e., "WHAT IF" features, Ms. W analyzed the consequences of changes in reserves for unreported claims, in handling of net surplus, and in use of economic indices.

Inputs to the model included factors on claims paid, claims incurred but unreported claims, premiums paid, inflationary adjustments to fee schedules, and ratio limits of claims to premiums.

The output of the model consisted of recommended rates for each of the benefits for each of the corporate divisions and subsidiaries included in the Trust operations. In commenting on her model development experience, Ms. W says: "The basic calculations could all be done manually but the additional analysis which the DSS performed so readily would likely not have been attempted. The ease of obtaining additional information can only serve to increase the effectiveness of my decision making. Having never worked with such a system before, I was amazed at how quickly I could move to actually obtain results from it. I feel that we have adopted rates which are more realistic than we would have by using the normal procedure."



Several points can be made regarding the apparent success in developing this DSS model. First, by using a problem which had previously been solved manually, there was no additional difficulty encountered in problem formulation. Since the models for the various "benefits" were very similar in their structure, it was a simple matter for Ms. W to reproduce the basic model with the appropriate factor value adjustments. For example, the reserve for unreported claims for medical benefits is equal to 3 months' claims, while for dental and weekly indemnity it is equal to 2 months' claims. The "basic" model was essentially a prototype for the others. Once the results from this model were validated with those of the manual calculations, this allowed ready acceptance of output from model extensions. One example of such an output was the effect of recommended rate changes on the Trust fund. This was highlighted by a cash flow report, with changes in rates being allowed at different points in time.

As to the lasting value of the model, Ms. W asks that "while many assumptions were required in the cash flow analysis, the DSS features allowed for easy manipulation of variables to produce results under different alternatives. This provides us with information which will be useful in making profitable investment decisions."

PROJECT 17: Economic Analysis of Engineering Projects

The DSS developed in this project incorporated economic analysis as part of a larger engineering design project. In a consulting engineering business, a common task is the preparation of cost-benefit analyses involving incremental investment. In the pre-design phase, this activity tends to be superficial and handled manually, with the result that possible bottlenecks are not identified until they are imminent.

The development of this DSS was undertaken by two engineers in a consulting firm, one of whom was interested in marketing the firm's services, and the other in the planning of proposed projects. The impetus for this model was provided by exposure to a new tool (i.e., a DSS language) in a classroom which could be applied to a familiar and time-consuming problem in the work environment.

In order to lend immediate credibility to the DSS, the developers used a previously completed study (on design modifications to a paper making machine) for which the results had been computed manually. Duplicating the logic from this

"baseline" study in a DSS model, they were able to demonstrate that the model produced the same results as before. Next, they added information (on cost indices) to their model which had been available but not used in the "baseline" study. The results of the comprehensive analysis pointed to the same conclusion as the baseline case, but with an added emphasis: the investment was feasible, but the DSS allowed further study, confirming that a critical variable was the speed of the paper machine. In fact, in this case this parameter was much more important than capital cost considerations. As they noted, "this emphasis is exactly opposite to the normal practice of producing as good an estimate of capital expenditure as possible. In fact, if additional engineering time is needed to be spent, confirmation of the speed increase assumption would be a much more valuable task in reducing uncertainty that the expected economic returns would be achieved."

The DSS language used was one which had been acquired by their company, and operated in an interactive mode on an in-house computer. One of the developers had previous programming experience in FORTRAN, and also attended an introductory session on use of the DSS language. The other developer acquired most of his computing knowledge in a process control environment, and for the DSS language by a process of osmosis in interacting with his co-developer. Both exhibited an

extremely positive attitude to the use of computers for decision-making purposes, although they noted that this was less likely to be true on a company-wide basis.

Referring to their experience with the DSS, they noted that "the ease of use of this system makes it a very valuable tool to the investment analyst. Most important, it is a tool which he can use and control himself, in a timely way. He does not have to submit work to a "computer shop". This system can justifiably be termed a Decision Support System.

Encouraged by their initial successes with the DSS model, they extended it to include an ex ante analysis. Their original forecasts of model variables were replaced by more current estimates. They also recognized the impact of new legislation on investment write-off periods, which lowered by 50% the amounts which could be claimed in the first year. As a consequence, the project outlook turned considerably more pessimistic. While this exercise was clearly a "retrospective piece of work, not suitable in the design process," the range of analyses available using the DSS approach demonstrated a significant improvement over the manual calculations used on the original project. Interestingly, they conclude that "in an all out race we would judge that we could get a "first run" answer from the DSS faster than by hand."

The input data to the model was a combination of known or forecast information. The model outputs were typically pro forma financial statements, detailed budgets, or estimated return on investment. Other outputs included technical factors of production such as energy requirements and optimum machine size.

The interaction between the two developers during the modeling exercise reflected a continuation of their normal working relationship. The benefits of having a DSS as part of the firm's services was felt to give it a significant marketing advantage.

PROJECT 18: Resource Allocation in a School Board

The DSS project objective was to develop a model to help school board adult education administrators to allocate time and monetary resources to their programs for maximum social benefit. The developer of this DSS was Ms. Z., an experienced educational administrator herself, who is quite familiar with the difficulties of quantifying social benefits. She summarized her approach to the DSS project as follows:

"Coming from the educational stream, adult education administrators have little training in business management or financial modelling, and they traditionally resist methods to quantify a value for the educational product. It is presumed that a social benefit accrues, but it is indirect and may vary in different communities. There is no consensus on a measure of social benefit, but overwhelming concern that program planners are running their fastest to stay in the same spot. Development of a model to quickly cost the results of their decisions, leaving the individual and perhaps their school board to subjectively evaluate the benefits, seemed useful. Every administrator must confront the bottom line although the cost and revenue components may vary."

The data requirements for the goal programming formulation of the model were to be primarily met by using results from a SPSS (a "package") computer program analysis of the market. The method considered was to transfer SPSS output data to the DSS model directly as a machine readable file, but Ms. Z.'s unfamiliarity with SPSS and file communication abilities of the DSS language rendered this approach infeasible.

The time constraints on the DSS exercise did not permit manual transcription and re-entry of data, and the goal programming formulation was not pursued any further. Instead, it was hypothesized that an administrator could use sensitivity analysis to calculate the effects of external and uncontrollable events such as a sudden drop in enrollment, or could evaluate the effect of changes in class size, fee structure, costs, etc. or to consider alternative allocation of resources such as instructor time or dollars.

The reduced scope of the DSS project was accepted by school board administrators, and the data for the model was painstakingly assembled from available school board statistics.

However, the model never performed as desired. Ms. Z's interpretation of the user manual instructions for the DSS language led her to try a variety of methods of setting up the model to make it amenable for performing sensitivity analysis, but with no success. Compounding her problems were slow response times from the computer system, difficulties with terminal operation and keeping up her user's expectations. The DSS was never quite operational, and demonstration sessions with her user had to be abandoned.

The initial expectations were not realized, and Ms. Z notes that she is not likely to again attempt developing a DSS model on her own.



PROJECT 19: Profit Forecasting for a Consulting Service

Mr. AA is a senior administrator in Company X, a firm of consulting engineers. This firm is a regional operation with a few branch offices; it has recently merged with Company Y, a national operation with larger branch offices.

Company X, Mr. AA's old firm, has always managed its financial affairs in a centralized environment from its head office; there has been very little interaction with the branch offices, and its financial planning has been done with pencil and paper. Company Y, on the other hand, has operated its branch offices as completely separate operations who handle their own financial affairs; their general level of financial planning is quite sophisticated.

Mr. AA believes that as a result of the merger, Company X's financial planning techniques will have to be at par with its partner. There is also a likelihood that both companies will move to a new common format for reporting purposes, although for the present both companies are operating as independent entities.

Mr. AA has developed this DSS to explore the possibilities of using his current branch office financial reports as a basis for more sophisticated analysis of Branch operations. The "Branch Statement Summary" is a report put out each month for each office in Company X. The key comparative figure is the operating income for each branch expressed as a percentage of revenue. The higher this percentage, the more successful an office is considered in its operation.

This summary report is sent out by head office to its branch offices with a memo indicating significant achievements, targets and problems for factors such as revenue, direct consulting project costs, administrative and overhead expenses, promotion expenses and operating income.

The basic objective of this DSS was to estimate future values for the various line items of the Branch Statement Summary report. Using Mr. AA's own judgment and experience in his branch operations, the model examines the sensitivity of various operating expense to revenue ratios with respect to several controllable and uncontrollable factors.

Since these ratios are derived from aggregate statistics of costs and revenue, Mr. AA first undertook a more detailed financial breakdown of specific line items. For example, the

category of overhead expenses resulted from adding up employee and professional activities, accounting services, employee training and general office expenses. Making reasonable assumptions about growth in business, and recognizing that this growth would be accompanied by a growth in staff levels. Mr. AA added in requirements for new floor space once the staff levels exhausted current capacity.

Since profit sharing is regarded in Company X as a traditional and useful employee incentive, the effect of various cost changes on this factor was also included for study. One interesting result from the model was that even with the use of mainly linear functions for business growth (in terms of revenues and expenses), the net annual bonus per employee did not change linearly.

Mr. AA noted a few "goofs" in his efforts at setting up the model. Sensitivity analysis, for example, required input of a percentage change to the base value of a specified parameter. However, if the parameter is itself expressed as a percentage, the results are not as one might anticipate. "I had to realize that a 10 percent increase in 42 percent gives 46.2 percent and not 52 percent."

Another issue concerned the large volume of printed output

that might be generated from use of the sensitivity analysis feature. Examining outputs from incremental changes of one percent in the base value of a parameter produces "a lot of output, so one needs to be selective in specifying these limits." In commenting on the accuracy of model results, Mr. AA noted that "because I know the relationships in my mind and am well aware of how we as an office can increase operating efficiency, a lot of the results are as I expected. I realize though that many of the percentage changes are worthy of note."

Since one major cost category is employee salaries, and revenues are generated only when employees are being "charged out", Mr. AA wanted to determine the ratio of salaries to revenue for a prespecified level of operating income to revenue, i.e. a profit objective. The "goal seeking" feature of the DSS language allowed him to conclude that salaries would have to decrease by 7 percent for the firm to reach this profit objective. While this model does not indicate exactly how this objective will be achieved, it does provide Company X's management with a quantifiable target. Still, he notes that "while a more detailed examination of their output data could show which factors should be tackled first, unfortunately many of these variables are a function of human behaviour. For example, project management and cost control statistics

cannot be improved upon quite that easily. Other factors such as staff non-utilization can be controlled by laying off personnel as soon as we are not busy, but that involves human lives. Our Company does not operate that way!"

As a possible extension of the model, Mr. AA would create similar models for other branch offices of his company, and "consolidate" the results for a corporate picture of the combined operations of Companies X and Y.

PROJECT 20: Commercialization of an Invention

The DSS model was developed as part of the initial assessment of the feasibility of commercializing a new product invention. The product was expected to provide an answer to special lighting problems for designers of commercial and industrial buildings.

The DSS model developer, Ms. BB was a marketing research executive, in her early thirties, with considerable experience in her field. Her previous experience with computers was primarily in the use of statistical analysis programs such as SPSS (Statistical Programs for the Social Sciences); thus this project offered her an opportunity to develop a financial model to reflect certain aspects of the findings from her market research studies.

The primary objective was to develop a five year forecast of sales and expenses associated with introducing this product. Risk analysis features of the DSS language offered a means of capturing the uncertainties associated with market size, market share, financing and development costs.

Anticipating full co-operation from the sponsor, Ms. BB developed a DSS model to consider the financial implications of adding this new lighting system to the operations of the sponsor company. However, after the data requirements were identified and the model was developed, the sponsor company withdrew its support in terms of providing financial information about its current operation. In hindsight, the necessity (in DSS models) to make assumptions explicit may have been interpreted as a threat to the company by requiring it to "open up its books". Another factor may have been the working relationship between the sponsor company and the inventor. The latter's work had been underwritten to some extent by the sponsor company for Ms. BB's market research studies, but the inventor still wanted to exercise control over the commercialization of his invention, as well as obtain royalties from the sales of the product. As a consequence, agreement on the specific alternatives to model was not reached, although these were well within the capabilities of the DSS language and Ms. BB's abilities to incorporate them in the analysis.

The problem was then reformulated to reflect the incremental contribution which the product would make to the "bottom line", assuming an independent manufacturing facility for this product. This analysis highlighted the need to attract venture capital in the early stages of product development,

and also persuaded the inventor that offering the product at this stage would not provide sufficient reimbursement of his development costs through estimated royalties.

Ms. BB notes that "the use of the DSS model in completing the financial section of the feasibility report was valuable because it required assumptions to be stated and evaluated. Development of a financial model forced the evaluation of reasonable values for sales volume and expenses. In a very real sense, the search for parameter values to fit the original model forced the sponsor company to withdraw their support because it was unable to satisfy the information requirements. Still, the creation of a financial model was a valuable exercise for all individuals of the development team by providing a framework for discussing their interpretations of the assumptions, and it led to developing a blueprint for financial action."

In its revised and limited form, the model was still able to identify a key variable for further investigation; the effect on cash flow of high startup costs of setting up a facility to manufacture the product could be lessened by the exercise of tax options for the treatment of capital-cost allowances.



This DSS highlights some of the problems associated with management of small companies and commercialization of inventions. The quantification of parameters has some obvious advantages, but also poses threats in forcing these assumptions to be made explicit to "outsiders".

PROJECT 21: An Operating Budget for a Community  
Newspaper

The developers of this DSS are Mr. C, the publisher of a weekly community newspaper and Ms. D, an accountant. For Mr. C, this project represents his first exposure to a computer system. He expects this effort to assist in evaluating plans for increasing his newspaper circulation. He hopes to achieve this by replacing the old printing plant with modern computer-based equipment, and use it to attract more advertising revenue and increase circulation. He plans to offset his costs by renting out any excess plant capacity.

Ms. D, who is quite familiar with financial analysis techniques establishes the information items for which input values are required. Mr. C uses his knowledge of the business to develop the necessary figures. He extracts the cost data from company records, and generates the sales and revenue projections from discussions with his sales personnel. He also inputs his own estimates of operational efficiency that would become, achievable with the new printing plant.

The relationship between Mr. C and Ms. D in this project is more like that of a DSS user and a DSS developer than that of co-developers. Ms. D performs all of the quantitative analysis and computer-related operations, while Mr. C becomes increasingly familiar with the report formats generated automatically (i.e., as a system default option) from the DSS software package.

The first set of output figures comes as a shock to Mr. C, since it reveals that his plans for capital investment would cause the newspaper to lose money over the next few years. He then uses the sensitivity analysis features of the DSS language to determine the break-even levels corresponding to (1) increasing operating efficiency and (2) increasing advertising and circulation revenues. The results of both analyses are discouraging; in Mr. C's opinion, none of the break-even targets are achievable.

Mr. C is fully aware that although the newspaper is generating a modest profit for its owners, the threat of competitive actions makes it extremely risky to continue with his current mode of operations. In discussions with the owners of the paper (unrelated to the above analysis), he learns that the newspaper will be sold if it cannot be made a more profitable operation in a very short time.

From his previous DSS analysis, he has already concluded that such increased profitability is not a likely outcome. He quietly looks around, and secures a good position with another company, on the strength of his "successful" track record.

As a post-script, the high cost of money has made it difficult for the owners to sell the newspaper; it has also discouraged the potential competition from entering this market. The newspaper continues to generate a modest profit for its owners.

APPENDIX IV: MANAGERIAL PROBLEM SOLVING AND DECISION MAKING A  
AND MODELS

1. Introduction

What is a decision? It is an output of a person's thinking or his problem solving. Problem solving in turn is a process, with the purpose of generating a feasible outcome, a decision leading to the accomplishment of some goal through the implementation of an action plan.

The area of interest for this research study is a small subset of the rather large field of problem solving, and is limited to an exploration of frameworks which lend themselves to decision support for managerial problem solving.

2. Wilcox model of decision process

Wilcox (1972) distinguishes between two predominant models of decision processes in terms of the choice sets considered. A choice set is the set of alternatives which may be considered before a choice is made. He states:

"... processes which allow search to stop and the choice to be made before all alternatives within a specified choice set are considered are termed satisfying models. ... Those that require all members of a prespecified choice set to be considered and the best one chosen according to some criterion are termed optimizing models." (p 12.)

The second type of decision process described by Wilcox is exemplified by microeconomic models; these impose some critical limitations in the study of individual decision making. Their normative viewpoints assume away factors such as memory limits or time deadlines applicable to a particular decision maker. The first model is perhaps more representative of managerial decision making and supported by the findings of other researchers, as discussed below.

### 3. Anthony's Framework

Anthony (1965) proposed a framework for the study of planning and control systems by categorizing managerial activities in an organization in terms of strategic planning, management control and operational control. These three categories lie on a continuum of the types of decisions made in an organization, and represent increasing constraints on the use of managerial judgment. The information requirements of each of the three categories are very different from each other. As Keen and Scott Morton (1978) note, "the difference is not simply one of aggregation, but reflects the characteristics of the information required by managers."

(p.82)

4. Simon's model of problem solving

Another approach is taken by Simon (1977, p.6) in his general discussion of human problem solving. He distinguishes between "programmed" and "non programmed" decisions as ends of a continuum, as follows:

- (i) Decisions are programmed to the extent that they are repetitive and routine, to the extent that a definite procedure has been worked out for handling them so they don't have to be treated de novo each time they occur.
- (ii) Decisions are non programmed to the extent that they are novel, unstructured, and consequential. There is no cut-and-dried method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment.

By non programmed I mean a response where the system has no specific procedures to deal with situations like the one at hand, but must fall back whatever general capacity it has for intelligent, adaptive, problem-oriented action.

According to Simon, "problem solving may be viewed as a way of reaching non programmed decisions by reducing them to a series of programmed decisions." (p. 70.) Simon claims that all problem solving can be broken down into three categories:

- (i) Intelligence: an awareness that a situation requires a decision.
- (ii) Design: decision maker enumerates and evaluates the alternatives available.

(iii) Choice: selection of a particular course of action from alternatives outlined in Design phase.

A fourth category of Implementation is also implied in Simon's framework; this is the process of carrying out the decision.

5. McCosh and Scott Morton's framework

McCosh and Scott Morton (1978) use the terms "structured" and "unstructured" in preference to "programmed" and "non programmed" because, as they note, "they imply less dependence on the computer and more concentration on the basic character of the problems." In an unstructured problem, the human decision maker provides significant levels of judgment, ad hoc evaluation and insights into problem definition; for very structured problems, much if not all of the process can be automated.

Simon makes the point that this problem-solving process is highly iterative and hierarchical. The intelligence phase is itself a complex process, which requires the decision maker, in order to "find" a problem, to go through the intelligence, design and choice phases.



## 6. Pounds' problem-finding process

Pounds (1969), in his discussion of the subject of problem finding, identified four models which managers can use to represent the problem or phenomenon in question. The importance of these models to a manager is that it helps him decide which problems to identify and to address. Pounds refers to these as:

- (i) historical models: these tend to depend on data derived from the observations of past experiences
- (ii) planning models: these involve detailed projections of key operating variables, to estimate the likelihood of future difficulties
- (iii) other people's models: these are models of the behaviour of an organization in the minds of other people, whose input is considered important by the manager
- (iv) extra-organizational models: these are models created outside the organization.

## 7. Problem Structure and DSS

Once a manager or a decision maker has found a key problem area using one of the above types of problem-finding models, techniques such as decision support systems can be used to solve them.

In a fully structured problem, all three phases identified by Simon, namely, intelligence, design and choice are structured, and algorithms can be used for problem solution. If all three phases are unstructured, the problem is completely unstructured; solution techniques here would include the use of managerial judgment and experience.

There is a grey area between the structured and the unstructured problems referred to as semistructured problems. The combination of the manager's judgment and the computer's power can produce more effective decisions than either approach on its own. It is in to this area of semistructured problems that decision support systems have been most successful.

APPENDIX V: MANAGEMENT INFORMATION SYSTEMS: APPLICATIONS,  
IMPLEMENTATION AND RESEARCH FRAMEWORKS

1. Introduction

Management Information Systems (MIS) represent the first major attempt to apply computers to problems in managerial decision making. Lessons learnt from successful and unsuccessful implementation of MIS have proven important to determining the evolution of decision support systems (DSS). The early research in DSS benefited greatly from the work previously undertaken in the MIS area.

2. Historical Background of EDP/MIS applications

Computers have been applied to business applications since the middle fifties, and in that time we have witnessed the evolution of four generations of technological development. The term EDP denotes electronic data processing and broadly covers the processing of data, both for business and scientific applications, by electronic computers. MIS stands for Management Information Systems, and represents a considerable

enhancement of EDP concepts in business applications, and made possible by advancements in both computer hardware and software.

From the the mid-fifties to the early sixties, EDP systems tended to be fairly basic, in that each data processing task was a self-contained job, with its own separate file of computer data. Examples of basic EDP system applications would include Sales Order Processing, Customer Billing, Accounts Receivable, Accounts Payable and Payroll. The output from these systems consisted of processed transaction data and summary reports. As the examples imply, these applications represented activities within one functional department in the organization, with the output aimed mainly at the operating management level. The primary justification for the development of these systems was in cost savings made possible through the displacement of clerical personnel who had previously processed the data on a manual basis.

The mid-sixties saw the introduction of the second generation of computer technology; the IBM System 360 line of computers would be considered as typical of this generation. The trend was now towards integrated data processing, with the same data and computer files being used in more than business application; systems were linked by the output from one application being used as the input to another. This integration made

possible the development of more complex systems such as inventory control and sales forecasting. However, although the applications now cut across different departments in the organization, they continued to be essentially transaction-based systems and were still oriented in their information content towards decisions at the operating management level.

With the third generation of computer technology, using the IBM system 370 line as an example, use of data bases became possible through the availability of large, on-line, secondary storage media (such as disks and drums), and software systems for managing them. The large quantities of data needed by the different functions of the organization called for a large storage capacity; the integration of these data were made possible by software (referred to as Data Base Management Systems) which reduced the need to store data redundantly. One copy of a data item could now be stored, and accessed by various computer programs from a common data base.

The possibility of supplying comprehensive management information through an expansion of integrated data processing services gave rise to the term Management Information Systems (MIS). This topic of MIS has proven to be a very controversial one, and as yet there is no general agreement on a definition. Conservatively, it refers to the combination of transaction-based EDP systems and the scheduled reports aimed

at management. With this definition, almost every company has an MIS. The controversy of an MIS definition arises from the more ambitious claims made for it, that it should provide all elements of the organization with information needed to function effectively.

It was the decision-support orientation of MIS that largely distinguished this concept. Yet it was the difficulty of MIS to satisfy the large variety of information requests that created much of the controversy. Scheduled reports and reports on demand represented "structured" requests and could be satisfied; "unstructured" requests such as for future-oriented data were not as easy to satisfy in a timely manner.

The move to MIS created two sets of pressures in organizations which adopted it. First, with data bases, MIS represented the threat of centralization by advocating the collection of data just once at its source. Since this data could now be accessed by the entire organization, a number of clerical jobs would become redundant. Also, since an MIS application cut across functional boundaries, a number of middle management positions would also become redundant. The second pressure arose from the fear that misuse of data in a centralized data base could lead to the invasion of privacy of an individual or a group; this pressure caused a variety of consumer and

governmental agencies to promulgate rules and regulations to safeguard against this possibility. While no concrete statistics are available, there appears to a consensus that companies have moved fairly cautiously in embracing the MIS concept.

The critical linkage in the relationship of MIS to transaction-based operating information systems is in the form of a central data base. This data base contains organizational data generated by transaction-based systems, as well as external data and information obtained as a separate data collection and processing exercise (Murdick, 1980).

The steps for a successful MIS development can be visualized as a sequence of planning, design, implementation and control activities. The execution of the steps call for a unique type of individual -- one who is a specialist in computer systems design and MIS concepts and one who is also knowledgeable in the management decision-making process to be able to adequately collect the information required in the steps listed above. The differences between two perspectives, that of the system specialist and the manager, has been cited by Carroll (1982) as a critical problem in implementing MIS.

### 3. Implementation Issues in EDP/MIS

#### (a) A definition of implementation

One definition of implementation generally used by computer specialists is that it is the last of a number of steps in systems design, encompassing conversion and installation of a new system. Another definition recognizes it as a component of organizational change associated with a new system.

... it is a part of a process that begins with the very first idea for a system and the changes it will bring. Implementation terminates when the system has been successfully integrated with the operations of the organization. (Lucas, 1978b, p. 77)

#### (b) Indicators of successful implementation

Researchers have not really agreed on an indicator for successful implementation. One approach is cost-benefit study, but meaningful estimates of benefits of a computer-based information system has eluded most analysts. Another measure applies to systems where use is voluntary. Here, high levels of use as established by the user would be regarded as



a measure of successful implementation. A third measure is one of user satisfaction, relevant for systems where use is not mandatory. Satisfaction is a composite of such factors as quality of service, timeliness and accuracy of information, etc. It thus tends to be a subjective measure. The last two measures reflect the viewpoint that if a system is not used or the user not satisfied, it cannot be considered a success even if it functions well on a technical basis.

(c) Implementation Issues

There appear to be three major problem areas in systems design and implementation. The first category is technical; the design and operation of information systems have long been considered primarily technical activities. Nevertheless, technically advanced products such as low-cost, easy-to-use computer terminals, large data bases and associated data base management systems, reliable communication networks, and proven software packages are now readily available and are examples of the adequate technology which can be used to develop fairly sophisticated information systems. Technical issues are only infrequently highlighted in discussions on implementation. The second category is one of organizational structure, and reflects the changes caused by the introduction

of new computer-based information systems. Examples include changes made to an individual's job content, the establishment of new work relationships and on a larger scale, changes in organization structure. Resistance to change has been cited by many researchers as a manifestation of this category of problem factor. The third category is one of project management, i.e. the management of the entire process of systems design up to implementation. The process of systems development is carried out by people drawn from the pools of computer specialists as well as users. The differences in their attitudes, behaviour, language and orientation must be taken into account if effective systems development efforts are to be achieved.

Carroll (1982) points out that "the differences between these two groups are normal and are the result of the demands of their respective jobs ... knowing what these differences are, however, is an important bit of behavioural knowledge that is helpful to all those involved in systems development." (p 45).

#### 4. Research Frameworks in MIS Development and Implementation

As early as the late sixties, concern was expressed about the high rate of failure in MIS implementation.

Ackoff (1967, p 147) commented:

"Contrary to the impression produced by the growing literature, few computerized management information systems have been put into operation. Of those I've seen that have been implemented, most have not matched expectations and some have been outright failures."

Researchers in MIS have, since the mid sixties, attempted to establish frameworks for MIS which could be used in identifying factors which influence the success and failure in developing and implementing these systems. A framework essentially provides future researchers with a relevant context for both - organizing their research, and in the interpretation and evaluation of their results.

##### 4.1 Anthony's Framework for MIS

Anthony (1965) was one of the earliest researchers to propose a framework for MIS. He argued that an organization's structure and its information system are in reality just two sides of the same coin.

In practice, it is somewhat difficult to separate the activities of planning and control; they are essentially different points in a continuum. Strategic planning (a top management activity) occupies one end of this continuum, management control (a middle management activity) occupies the middle, and operating control (an operating management activity) occupies the other end of the continuum.

The major implication of Anthony's framework is in its recognition that

"managers throughout an organization have varying information requirements, which is understandable in light of the differences between managerial positions. Consequently, an MIS must be carefully designed to serve management's wide spectrum of information needs."

(Watson and Carroll, 1980, p 378).

#### 4.2 Mason and Mitroff's Framework for MIS

Mason and Mitroff (1973) proposed a framework for research on MIS by defining an information system as:

...consisting of at least one PERSON of a certain PSYCHOLOGICAL type who faces a PROBLEM within some ORGANIZATIONAL CONTEXT for which he needs EVIDENCE to arrive at a solution, where the evidence is made available through some MODE OF PRESENTATION. (p. 475).

Mason and Mitroff suggested that MIS research should systematically manipulate the variables capitalized in their above definition to further explore the characteristics of an MIS.

#### 4.3 Chervany, Dickson and Kozar's Framework for MIS

Chervany, Dickson and Kozar (1972) identified independent variables relating to the characteristics of the decision maker, the decision environment and the information system, and proposed a framework which related these independent variables to a dependent variable which they termed quality of decision effectiveness, and measured by cost, profit, time, etc. Their framework represents their contention that knowledge regarding MIS design can be obtained by an experimental investigation of these variables.

This research framework formed the basis for a study which has become known as the Minnesota experiments. Dickson, Senn and Chervany (1977) have reported on the study, which comprised a series of experimental games:

"...it is wrong to assume that all decision makers are the same and can effectively function with undifferentiated information systems."

Benbasat, Dexter and Mazulis (1981) use a research framework similar to the one developed by Chervany, Dickson and Kozar (1972), and contend that it "implies that the goal of the system designer is to improve the level of human/computer effectiveness."

#### 4.4 MIS Framework of Lucas

Lucas (1975) developed a descriptive model of an information system, relating system performance to its use. His model can be written as a joint system of equations:

$$U = f(P, S, I, D, A)$$

$$P = f(S, I, D, U)$$

in terms of the use of the system (U), the performance of the system (P), situational factors (S), personal factors (I), the decision style of the user (D), and the attitudes and perceptions of the user (A).

Subsequent research by Lucas (1978) generally supported his descriptive model although he felt that further research was warranted:

"More research is needed to examine the ways in which attitudes relate to implementation success and to determine which attitude components are most crucial. More sophisticated studies should include different attributes of attitudes and try to determine the relative importance of the attributes in influencing behaviour towards a system." (Lucas 1978, p.39)

#### 4.5 MIS Framework of Ghani and Lusk

Ghani and Lusk (1982) have recently proposed another conceptual framework to consider MIS design issues, which closely parallels the frameworks proposed earlier by Mason and Mitroff (1973) and Dickson, Senn and Chervany (1977). This framework highlights two composite variables: individual differences in decision makers and a complex environment. The latter variable is defined as a composite of task differences and task environment. Ghani and Lusk use this framework to offer MIS design considerations for:

- (i) the availability and usefulness of information
- (ii) the context of the information processing task
- (iii) the amount of information to be processed
- (iv) the way the information is presented
- (v) changes in the mode of presentation
- (vi) the effect of individual differences on information processing

While they state that "these MIS design considerations have proven useful in our MIS design and implementation efforts", no corroborative evidence is presented in their paper.

Swanson (1982) identifies two motivations for researching MIS user attitudes. He uses the term "information perspective" to describe one approach; here, user attitudes are taken as reflecting the value of an information system to its users. The concensus of this line of work is that, broadly speaking, MIS attitudes are related to MIS use. The long term research objective here is to develop a theory of MIS utilization. The studies of Dickson et al (1977) and Benbasat et al (1981) are in this perspective.



A second research perspective, termed the "implementation perspective", aims at establishing a theory of MIS development, in which MIS success and failure is explained, and is closely associated with research in OR/MS. Lucas' study described above is an example of this approach. Swanson contends that while these perspectives are often distinct, they are ultimately complementary since a theory of MIS development requires a theory of MIS utilization.

APPENDIX VI: OPERATIONS RESEARCH AND MANAGEMENT SCIENCE:  
APPLICATIONS, IMPLEMENTATION AND RESEARCH  
FRAMEWORKS

1. Introduction

Decision support systems (DSS) have evolved from the experience gained with management information systems and management science. In order to understand the present direction of DSS research and implementation, it is necessary to be familiar with the information which relates to its predecessor disciplines. This appendix highlights the major developments in operations research/management science, which have led to the evolution of DSS.

2. Historical Background of OR/MS applications and related implementation problems.

OR/MS stands for Operations Research/Management Science, two terms used interchangeably to describe a disciplined approach of the application of mathematics to solve business problems.

Just as EDP/MIS applications demonstrate the data processing capabilities, OR/MS applications demonstrate the power of the computer's logic-data handling potential.

The word "model" is central to an understanding of the power of management science. According to Wagner (1975, p. 8), a model is

... almost always a mathematical ... approximation of reality. It must be formulated to capture the crux of the decision making problem. At the same time, it must be sufficiently free of burdensome minor detail to lend itself to finding an improved solution that is capable of implementation. Striking a proper balance between reliability and manageability is no mean trick in most applications, and for this reason, model building can be arduous.

Wagner's definition of a model focuses on management science's orientation to decisions as opposed to an EDP/MIS orientation to transactions. In this sense, OR/MS plays a more direct role for the use of computers in the decision making function. There is also an emphasis on the replacement of human decision maker by the computerized system, and in generating "optimal" decisions in the form of solutions from models. In "structured" decision making areas, management science techniques employed in conjunction with computers provide "programmed" decision making for solution to many problems.

The first era in the historical development of computer based OR/MS models began at the end of the second world war and continued until the early sixties. The models were mostly of production and physical systems, highly mathematical and well structured and gave analytic solution to problems, e.g. through optimization. Although these models were seldom understood by managers, they had high payoff for organizations.

The second era which lasted from the middle to the late sixties saw the development of "bigger and better" models. These models attempted a representation of the total systems involved, and as a result grew sharply in complexity. In technique they still favoured optimization and management still did not understand them, but these models no longer had the high payoff for organizations as did their predecessors. The models proved expensive to develop, and required input data which was not readily available in organizations. Their output often overwhelmed the manager's ability to understand, and forced them into a yes-or-no answer for accepting the results. Naylor (1981) cites an example of a model which took 23 man years and over 3.5 years of elapsed time to build, but for all practical purposes, the model was never used by management.

The third era lasted from the late sixties to the middle seventies, with an emphasis on developing usable models which could be implemented. Wagner's definition of a model, quoted earlier, reflects this point of view. Models of this era were designed to allow managers to test their judgement, tended to be smaller and simpler, and easier to validate. These models reflected an evolutionary approach to model building by posing the question: "does it help the manager in making better decisions?" instead of the earlier question "does it find the best decision?"

The evolutionary approach continues to-date, with an increased recognition that a decision maker should be closely involved in the model development process, indeed even be the designer and developer of his own models. Thus models could become an integral part of the approach that a decision maker takes towards a specific situation.

Recent research has compared success in implementing models developed with an evolutionary approach (called bootstrapping) with models developed with a total systems approach (i.e. the full scale model developed as one effort). The benefits obtained by managers through interaction with model development and accompanying "learning" process favour the successful implementation of "bootstrap" models.

The momentum of management science applications has extended from the area of "structured" decisions to semistructured and sometimes into unstructured decisions such as strategic planning. The use of a new type of model called simulation model has grown to tackle these problems. While previously models approximated a representation of reality, simulation extended it to the evaluation of alternative courses of action. Its main value has been in the testing of implicit models where analytic solutions may not even be possible. The development of powerful computer languages such as GPSS, SIMSCRIPT etc. added to the popularity of the simulation approach in business applications. The main task in this setup was to prepare the data in a format dictated by the modelling language.

Another model gaining popularity is of the heuristic type; the model simulates the cognitive process of the decision maker (including any rules of thumb which may be used). There is, however, no assurance that the procedures followed are optimal for the problem at hand.

The definition of the degree of structure of the decisions or systems being modelled have changed with time. Advances in management science have moved semi-structured decisions towards well-structured decisions, and from ill-structured to semi-structured ones. While OR/MS has provided a great impetus to the discovery of "programs" underlying business

decisions, their focus of replacing decision makers by a computerized solution has never been widely accepted in practice. The publicized success of OR/MS has mainly been in the domain of "structured" decisions.

The value of computerized models to managers can be easily demonstrated: As summarized by Wheelwright and Makridakis (1972),

- (i) it is an approach to decision making which requires clarity and understanding of the total situation and approaches taken
- (ii) it ensures consistency over repeated decisions
- (iii) calculations can be made by computer in a fast and accurate manner
- (iv) there is a possibility of better decisions through generation of alternatives by managers and evaluation by computer
- (v) it ensures time savings and consistency in the analysis of complex decision processes.

In spite of the values demonstrated above, there have been a variety of problems associated with the implementation of models in organizations. These implementation problems can be grouped into three categories (Cook and Russell 1977):

- (i) the nature of the client/researcher relationship.
- (ii) the level and kind of support received from top management.
- (iii) the organizational and external environment in which OR/MS is pursued.

The importance of education-related problems in the implementation of OR/MS models is forcefully noted by Grayson (1973). He makes a strong argument in favour of resolving the implementation problem by educating managers in the analytical methods of OR/MS, and offering training in general management to OR/MS practitioners. The real cause of the implementation problem, he feels is what Churchman and Schainblatt (1965) point to as the lack of "mutual understanding" between manager and the management scientist. Grayson foresees the need for a major educational effort to move both groups towards a common front for increased understanding. Keen (1978, p. 198) notes, however, that "while it may be true that the difference between the two groups causes problems, that



same difference is what makes each of them distinctive ... it seems very inefficient (and likely to be ineffectual) to try to educate each to be like the other".

### 3. Research Frameworks in OR/MS Model Development and Implementation

#### 3.1 Introduction

Literature dealing with OR/MS implementation has reached a significant volume; Wysocki (1979) has compiled a bibliography of almost 300 papers (75 percent of them written in the years 1973-79) on the problem of OR/MS implementation and Implementation Research. Wysocki classifies his bibliography into the following broad areas:

- descriptive studies of the frequency of use of OR/MS techniques
- empirical studies that attempt to identify factors related to the adoption or non-adoption of OR/MS techniques
- conceptual papers dealing with quantitative and/or qualitative models of the implementation process
- curricula of business schools that address the problem of implementation
- case studies of actual implementation

In a study of the relevancy of academic research on OR/MS implementation to practitioners, Anderson and Chervany (1979) concluded that firstly, the OR/MS managers interviewed were in general, relatively unaware of specific implementation research projects and results; and secondly, when presented with research results, perceived them as "not very useful." The authors recommend active collaboration between the two groups in order to effect a more productive relationship.

### 3.2 Conventional Wisdom on Implementation

The earliest approach to implementation of OR/MS models comes from the "wise old men" (Ginzberg, 1975), as a normative approach and is based on the extensive field experience of a number of MS researchers and practitioners. By reviewing cases with substantial implementation difficulty, they attempted to identify the general nature of implementation problems and derive general principles for solving them.

Looking at this literature as a whole, Ginzberg (1978) notes: "we find substantial disagreement on just what the solution to implementation problems should be." These disagreements arose in part from differences in definition of a "implementation problem", and in part from researchers generalizing from their experience based on a limited number of cases. The "wise old men" were usually oriented to telling their readers how to go

about implementation, as opposed to offering comprehensive implementation guidelines. Keen (1978) notes that "a characteristic of their approach is that they often define what one should do as being the opposite of what was done in projects that failed" (p. 194).

### 3.3 The Factor Approach

A second category of implementation study is represented by the "factor approach". Typically, a factor study would attempt to identify variables or factors considered potentially relevant to successful implementation outcomes. Data in the form of descriptions of large samples of implementation efforts would be analyzed to determine the relative importance of the different factors to implementation outcomes. The results from the factor approach have been disappointing. From Ginzberg (1975) identifies 140 distinct factors assessed in 14 factor studies. Of these, only 15 factors appear in 3 or more of the 14 studies, and 102 appear in only one study. Ginzberg (1978) notes that " the only result which is firmly established by this research is the importance of management support and user involvement to the successful implementation of MS (and MIS) projects."

Ginzberg's studies suggest that the characteristics of the particular situation must determine the approach taken, i.e. that implementation is a contingent process.

### 3.4 Implementation as a Process of Change

A third approach to the study of implementation is to view it as a process of change. It examines a factor well within the control of the model designer and the user, namely their individual behaviour. Examination of this behaviour leads to identifying patterns which prove effective or ineffective in achieving successful implementation. These patterns are then translated into strategies and tactics to improve the chances of successful implementation. The focus on managing this process of change distinguishes this approach from the ones previously discussed.

The most basic framework for discussing behavioural and organizational change is the Lewin/Schein theory of change (Lewin 1952, and Schein 1961). Change is viewed as including three distinct phases: unfreezing; moving; and refreezing. Each phase is concerned with changes in the balances of organizational forces, and their correlation with change.

The "unfreezing" phase explains a lot of our conventional wisdom. In referring to the development of an atmosphere where an individual can risk trying something new, potential success factors such as "top management support", "a felt need by the client", and "an immediate, visible problem to work on" all relate to "the need for motivation and a momentum for change" (Keen, 1978). Alter (1980) reports a lack of success in implementing systems where the initiators were technical people and not the users. This puts the onus for change on the user himself and also for continued commitment to the change program. "Resistance to change" reflects a lack of unfreezing, and the Lewin/Schein model recognizes that this resistance may be a reasonable response from a system that feels no motivation to adjust; that is, change, in itself, is not necessarily desirable.

The next phase, "moving", is the action phase of the change effort. This is the phase viewed in the technical tradition as equivalent to implementation; it consists of the design of the change program, including the presentation of information necessary for change as well as the learning of appropriate behaviours and attitudes. A system, once unfrozen, seeks a new equilibrium. "Refreezing" entails the stabilization of the change and the integration of the new behaviours and attitudes into the existing organization. The sequence of Unfreezing, Moving, and Refreezing is best seen as an iterative process.

Ginzberg (1978) offers three reasons for adopting this type of process-oriented view:

- (1) it leads us to consider the entire implementation process rather than only the "action" phase
- (2) problems often have their roots in an earlier stage of project development
- (3) looking at the entire process helps us develop a fuller understanding of the nature of these problems.

Kolb and Frohmann (1970) have extended the Lewin/Schein model to cover the consulting process in organizational development.

Two studies, by Zand and Sorensen (1975), and Ginzberg (1979) are based on the Lewin/Schein and the Kolb-Frohmann models respectively. Their results suggest that the process framework has substantial explanatory power. Among the results common to both studies are:

- (1) successful projects tend to conform more to the prescription of the process model than do unsuccessful projects.

- (2) the stage most closely associated with implementation success is Refreezing.
- (3) users and designers frequently disagree on their reports on conduct of the process and assessment of project success. Disagreements tend to be greater when the projects are judged unsuccessful by users.

### 3.5 Behaviour Patterns for Successful Implementation

Ginzberg (1978) distills for the designer as well as the user, behaviour patterns which are likely to lead to implementation success.

For the management scientist, these include the need to:

- (1) ensure that there are willing users who believe in the importance of their projects
- (2) stay involved and keep the user involved until he understands and is able to accept the system in his environment

- (3) recognize that each user is different. A system to satisfy the average user likely as not will not meet any user's needs
- (4) recognize that not all projects are alike with respect to technical, cognitive, interpersonal and political dimensions. He should be honest enough to back away from projects requiring skills he does not possess
- (5) decide at the outset whether he is going to be a technician or a change agent.

For the user, these include the need to:

- (i) recognize that different projects imply different degrees of change
- (ii) learn to understand both these differences and his own capacity for change. Allocation and availability of the required time and commitment must be established prior to undertaking the project
- (iii) carefully articulate project goals and objectives; this allows monitoring of the progress of the project



- (iv) recognize the responsibility to manage his relationship with the management scientist. First, to ensure that the designer has the necessary skills for the project. Second, to insist that the designer act as a change agent. Third, to periodically evaluate the progress of the project by matching perceptions with the designer.

In essence, these guidelines express the view that the most effective implementation will result from a total commitment of both the user and the designer to their common problem.

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