A STUDY OF MANAGERIAL COMPUTER USERS: THE IMPACT OF USER SOPHISTICATION ON DECISION STRUCTURE AND ATTRIBUTES OF DECISION-RELATED INFORMATION

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(ABSTRACT)

With the advent of information technology, MIS research has tried to understand and describe the impact of this technology on organizations. To date the vast majority of this research has focused on a macro-level of analysis. But the introduction of the microcomputer has significantly altered the focus of computing through the development of a body of managerial computer users. This study looked at the following questions: What factors constitute an information technology user environment? What are the usage and knowledge differences which constitute a concept of user sophistication? Do those differences significantly impact on a user's level of structured decisions and assessment of information attributes? To answer these questions a study was conducted of 229 middle managers in two academic institutions. The author developed a conceptual model of an information technology user to serve as the basis for the analysis. The study employed a multivariate regression analysis to test hypotheses developed from the user model. The results indicated that a positive relationship exists between managerial computer usage and a high perceived level of structured decisions. Furthermore, there was a strong association between a managerial user's level of computer understanding and his assessment of information reliability and sufficiency. The study also identified significant differences in a user's information technology environments and cognitive types.

Subject Areas: Information Technology, End-User Computing, Information Attributes, Decision Structure and MIS.

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I am very grateful to the two academic institutions, whose names must remain anonymous, for opening their doors and giving me an opportunity to study their managers.

Finally, I want to dedicate this dissertation to the unsung heroes of a married Ph.D. student, my family. First, to my wife , who has endured so much and received so little. I give to her my thanks and my love, for I couldn't have done it without her. Second, this dissertation is dedicated to my sons, My guys went without stories and other time to enable me to finish, yet always were encouraging and at six years have had the courage and love to tell their Dad he was being grumpy.

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Chapter 1: Introduction

A STUDY OF MANAGERIAL COMPUTER USERS: THE IMPACT OF
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RELATED INFORMATION

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> **Voluminous data exist on the technologies associated with the Age of Information, but there is little coverage of how managers can use these tools to improve themselves, their performance, their organizations, and society as a whole. (Morton F. Meltzer, Information: The Ultimate Management Resource, AMACOM, New York, New York: 1981: 29.)**

As the field of management has developed more sophisticated models of managing and organizing, the same evolution has begun to take place in information systems. In the past information systems research (Whisler, 1970; Simon, 1973; Winner, 1977; and Pfeffer & Leblebici, 1977) has examined the impact of centralized, mainframe-oriented data processing on the organization. These efforts have studied the effects of computer technology on issues such as decision centralization, reduction of organizational levels, span of control, decision structure and information characteristics.

Almost all the research to date has used an organizational (macro) level of analysis.[1] However, the advent of the microcomputer in the early 1980's, changed the nature of computing in organizations. Prior to the development of the microcomputer, accessing, processing, input and output were predominantly centralized and controlled by data processing professionals. With advances in information technology, the focus of computing has shifted from a central organizational core to a pluralistic body of users. These advances now enable users to access personal or desktop computers which surpass the capability of mainframes of the 1970's.

The microcomputer has substantially increased the sophistication and size of the user population (Guimaraea & Ramanujam, 1986; and Frand & McLean, 1986). Thus, in the study of information technology, an effort must be made to develop research procedures and instruments to identify and understand the differences among users. By identifying these differences, researchers can examine not only how information technology impacts on an organization, but also, at an individual level of analysis, how the differences in users may explain some of the variance in decision structure and information attributes.

It is important for information systems researchers to look at the impact of changing technology on individuals within organizations. Specifically, MIS research should explore how possible differences in the user population may affect traditional MIS impact measures.

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1 Level of analysis refers to the stratum in the organization where the hypothesis is tested, i.e. individual, group, or organizational level. Difficulties may arise when data for research are gathered at one level (e.g. the individual) and aggregated to another (e.g. the group or organization), because factors that operate on one level may not influence another level in the same manner.

Purpose of Study

The purpose of this study is to determine the impact of user sophistication on decision structure and on the attributes of information which relate to those decisions. These are two of the major factors used at the organizational level of analysis to study the impact of information technology on organizations. The goals of the research are to: (1) explore the possible existence of differences in users of computer information technology (i.e., User Sophistication); (2) explore the possible relationship between users' sophistication and decision structure (i.e., Structured versus Unstructured), and (3) explore the possible relationship between users' sophistication and the characteristics of the information used to support decisions (i.e., Relevance, Reliability and Sufficiency).

The difference between this research and previous endeavors is its development of the concept of user sophistication. Previous research (Whisler, 1970; Sumner, 1984; Robey, 1983; Foster & Flynn, 1984; and Cheney & Dickson, 1974) has considered only two categories of subjects: those who use computer technology and those who don't. This research seeks to develop a continuous construct of user sophistication which includes measures of both computer usage and computer literacy.

In earlier research, decision structure and quality of information have been examined in relation to: the presence of information technology (Cheney & Dickson, 1980); individual cognitive differences (Mock, Estrin & Vasarhelyi, 1972); and differing organizational decision environments (Blaylock & Rees, 1984). However, each of these examinations employs a narrow methodological approach or focus. For example, Cheney and Dickson look at decision structure as a function of the implementation of a computer-based information system. They examine only mean differences between pre-implementation and post-implementation assessment of decision structure, and did not consider how the type of information technology (or the respondent's cognitive differences or the differences in decision environment) could have influenced the variance measured by those group means. The observed variance was completely attributed to the presences of the information technology. This research effort will attempt to consider the impact of all the factors mentioned above while studying the possible relationships between user sophistication, and decision structure and information attributes.

Importance and Implications

The significance of this study lies in its treatment of users and the possible impact they have on decision structure and information attributes. This research effort hypothesizes that differences among users (in degree of sophistication) influence their perceptions of decision structure and information quality. If this is in fact true, then future research into these facets of information technology will have to explicitly consider individual user differences. The following sections examine the implications of this research in system design, system evaluation, and future research.

Design

Information has long served as the basis for system analysis in the design of information systems (Pressman, 1982).[2] If the level of user sophistication influences the way users perceive information, then the design process must take this factor into account. Otherwise the system design may fail because of a mismatch between the assumed level of user sophistication and the true level of sophistication. Wasserman (1980) and Lucas (1975a) indicated that this has become a major factor in information system failures.

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[2] Two of the more popular software engineering methodologies, Data Flow-Oriented Design and Data Structure-Oriented Design, use the information flow and information make-up (characteristics) as a basis for system requirements analysis which is ultimately used to design the information system (Jackson, 1975).

Evaluation

A review of the literature on information attributes shows that user perception of information from information systems has been used as a surrogate measure of system performance (King & Epstein, 1983). In other words, to determine the success or failure of an information system, users are asked to assess the quality of the information they receive from it. Research by Epstein and King (1982), and King and Epstein (1983) develops an empirical evaluation system based on information attributes appraisal. If, in fact, information attributes are related to the user's level of sophistication, then future system evaluations, based on information attribute assessment, must consider user sophistication as part of the evaluation process. The reason for this is that level of sophistication could bias the evaluation results. The direction of the bias would depend on the distribution of the user population and the nature of the relationship between user sophistication and a specific information attribute.

Future Research

If the relationships hypothesized in this research exist, future studies should consider individual differences as a component of the research program. This also applies to higher levels of analysis when data are gathered at the individual level and then aggregated. Varying levels of sophistication within an organization could significantly influence the data collected and the empirical results obtained.

Summary of Following Chapters

To guide the reader through the remainder of this dissertation the following preview has been provided.

Chapter	*Description*
One:	is an introduction to the conceptual framework of the research and the significance of the research for management information systems.
Two:	is a review of information systems frameworks. It looks at the body of information systems literature as it applies to the Gorry and Scott Morton (1971) framework and the concepts of decision structure and information attributes. This review develops the components of an Information Technology User Model. In the latter part of the chapter the user model is graphed and the research hypotheses are introduced and discussed.
Three:	presents the methodology which has been employed to test the hypotheses which were introduced in the second chapter. It discusses the subject population sites and the data collection. The instruments used and their development are reviewed in conjunction with the applicable source literature. Finally, the statistical methods which were employed to test the hypotheses are discussed.
Four:	presents the results of the research efforts. The chapter starts with an analysis of the respondents' demographics. The results of the Factor Analysis, Pearson Product Moment Correlation Analysis, and the Multiple Regression Analysis are tabularly displayed.
Five:	is a discussion of the results reported in Chapter Four. This discussion relates the research hypotheses to the observed results.
Six:	presents a summary and the final conclusions. It looks at the implications of the research findings and provides recommendations for future application.

Chapter 2: Literature Review

The following is a review of the current Management Information System literature which has been identified as relevant to the current research project. The review begins with an examination of the frameworks which have been proposed for the examination, discussion, or modeling of such systems. This review focuses on the development of the Gorry and Scott Morton (1971) Management Information System Framework. The components, which have been implicitly and explicitly stated in the information systems literature, are identified. These components are:

Decision Structure,

Information Attributes,

Decision Environment,

Information Technology Environment,

Individual User Perception and Judgment Types, and

User Sophistication.

In the latter part of the chapter these components are brought together into a conceptual model describing the Information Technology User, along with the definition of the relevant dependent and independent variables. Lastly, the hypotheses based on the relationships developed in the research model are presented.

MIS Framework

The goal of a management information systems (MIS)[3] is to put information into a useable form that is beneficial to the users of the system. Over the past fifteen years, several frameworks have been proposed for the conceptual modeling of these management information systems. The following is a presentation of the three most widely used frameworks. The first two, developed by Herbert Simon and Robert Anthony, serve as the basis for the third, developed by G. A. Gorry and Michael S. Scott Morton.

The first recognized MIS framework (Simon, 1960) is essentially a description of the problem solving process, and a categorization of those decisions. Simon concludes that decision-making is an essential and required activity for managers, and divides the decision-making process into three distinct phases or steps:

1. Intelligence. In this phase the decision-maker surveys the environment and identifies those conditions which may require action. Here, environment refers to conditions both internal (to the organization or unit) and external (outside the established boundary of the organization or unit). Theoretically, the earlier this identification can be made, the sooner necessary or proper action can be taken.

2. Design. Once the situation has been identified, the decision-maker develops alternative courses of action to resolve it. This phase involves selecting and processing information to determine the correctness and feasibility of these alternative actions.

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[3] The term "management information System" has two different meanings in the MIS literature. The first is a total or "meta" - system used by managers to meet their information needs, which would include all information sources, channels and processing procedures. The second meaning is that specific portion of the overall system which uses information technology (computers) to store, process and retrieve data (Huber, 1982). It is this latter meaning of MIS which is the focus of this research and is implied by any reference in this manuscript to a "management information system" or "information technology," unless otherwise specified.

3. Choice. In this phase, the decision-maker selects an appropriate course of action to resolve the identified situation.

Simon's framework does not explicitly include implementation or evaluation of the selected course of action. However, later adaptations of Simon's framework by Lucas (1982), Kepner and Tregoe (1981), Keen and Scott Morton (1978), and Alter (1980) acknowledged the importance of such activities.

A critical part of the Simon framework is its categorization of decisions into two types: **programmed and non-programmed.** This classification has been used as a basis for determining decision structure in most of the MIS literature (cf. Gorry & Scott Morton, 1971; Lucas, 1982; Huber, 1986; and Senn, 1982). Programmed decisions are repetitive and routine, and result from recurring situations in the working environment. Thus, a specific procedure is developed which can be applied whenever a similar situation arises. Little time is required for the design phase of this decision type. Simon also proposes that this class of problem or decision is analytic in nature and requires similarly analytic decision-making techniques. Mathematical programming, models, simulation and electronic data processing are examples of techniques which would be appropriate to this type of decision.

Non-programmed problems are described as novel, unstructured, and/or consequential in nature. By "consequential" Simon means that these decisions are important due to the uncertainty associated with them and a greater level of risk. Here, considerably more time is spent by the decision-maker in the design phase, since these problems have no definitive solution and probably have never arisen before (or very infrequently). Since this type of problem does not have an analytic solution, the decision-maker must rely on heuristic techniques. In organizations the decision-maker must be trained to respond in accordance with given organizational norms. This training and the use of heuristic programming provide the decision-maker with the information necessary to make the best possible choice, given the specific situation.

The important implications of the Simon framework are as follows: first, the significance of information systems lies in their ability to provide the decision-makers with quality information which will enable them to make the best possible decision. Second, decision structure is not discrete, but rather exists on a continuum. Programmed and non-programmed decisions represent only the extremes of that continuum. Last, though Simon's framework is not technology-specific, it mentions the use of heuristic computer programming as a technique for decision-makers.

The Anthony (1965) framework was developed at the Harvard Business School. This framework describes the decision-making process of managers and the construction of systems to support that process. The decision-making activities include strategic planning, management control and operational control. These activities are described below:

- Strategic Planning - managerial activities concerned with establishing, adjusting and changing the organization's objectives.

- Management Control - "the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives" (Anthony, 1965: 27).

- Operational Control - activities concerned with the effective and efficient accomplishment of specified tasks at the operational level of the organization.

Anthony develops in his framework a classification of decisions corresponding to each level of managerial activity. Key factors in this decision classification are the demand for and availability of information. Operational level decisions are more structured, having specific information needs which can be satisfied. However, decisions at the strategic planning level are more unstructured, having greater information needs with only partial availability of the required information.

The decision classes are listed below with sample information characteristics for each.

- Operational Control Decisions: characterized by information which is: (1) very detailed, (2) narrow in scope, (3) historical, (4) very accurate, (6) repetitive, (7) often non-financial, and (8) internally generated.

- Management Control Decisions: characterized by information which is: (1) moderately detailed, (2) historical, (3) predictive, (4) related to organizational objectives, (5) financial in nature, (6) based on exceptions to the norm, (7) accurate within decision parameters, and (8) generally internally generated.

- Strategic Planning Decisions: Characterized by information which is: (1) aggregated from the subordinate levels, (2) non-financial, (3) unique to a specific problem, (4) accurate in magnitude, (5) externally generated, (6) predictive in nature, and (7) used to establish policy.

The contribution of the Anthony framework is its establishment of a relationship between decision-making activities and the characteristics of the information used to support those activities. The information requirements for a decision are determined by the decision-maker and the specific situation. Information systems must provide information which is relevant to the situation and sufficient to reduce uncertainty.

A framework for the analysis of management information systems (see Figure 1 on page 12), was developed by G. Anthony Gorry and Michael S. Scott Morton (1971). This framework is the synthesis of the works of Robert N. Anthony (1965) and Herbert A. Simon (1960). Note the horizontal axis (labeled at the bottom of the figure) representing the decision structure, which managers must address regardless of their position. Gorry and Scott Morton extend Simon's decision structure concept ("programmed" VS. "non-programmed") into three categories: **structured, semi-structured and unstructured** decisions. The basic difference in this decision classification is in the amount of judgment, evaluation, and insight the human decision-maker must provide. Structured decisions are made in an environment of relative certainty, where much of the decision-making process can be automated. The quantity of information needed to make the decision

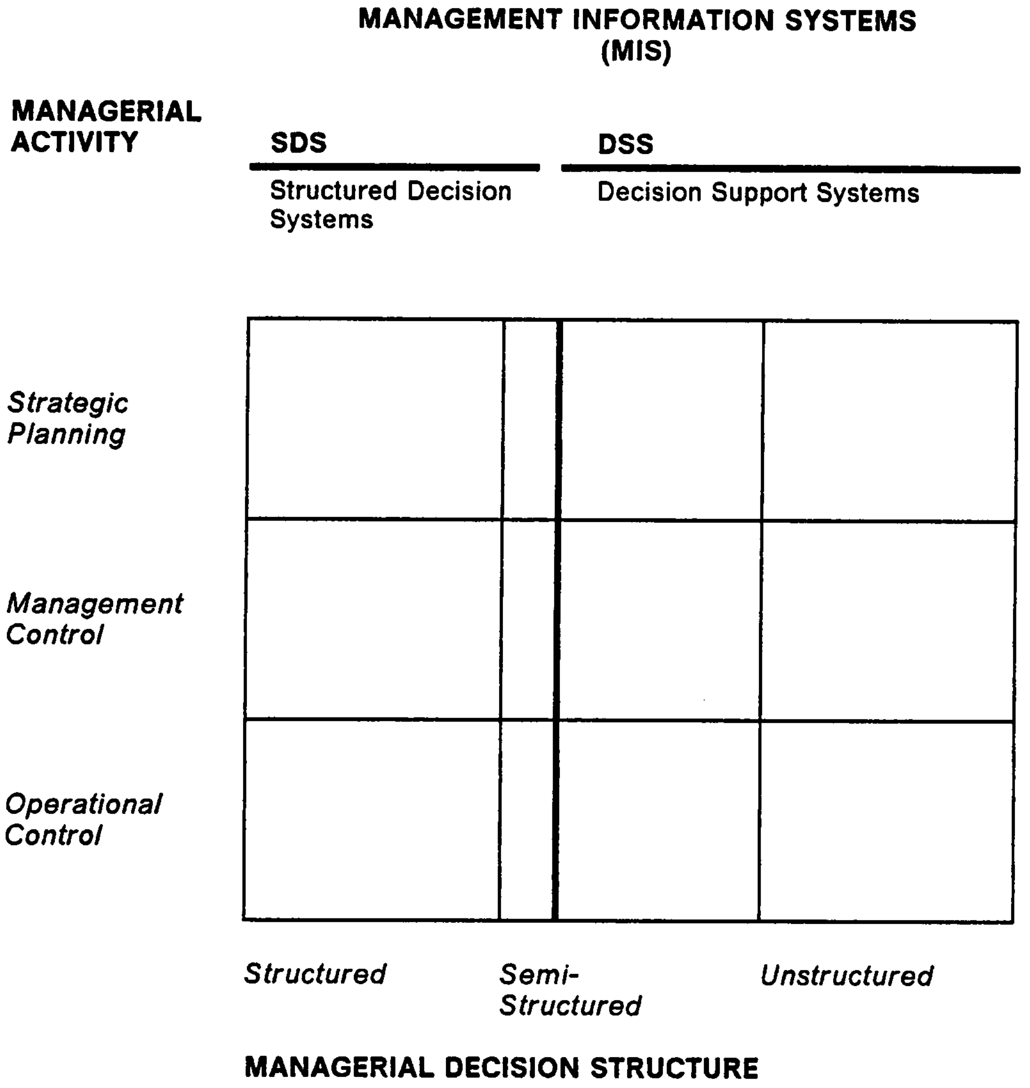

Figure 1. Management Information System Framework: Adapted from: G. Anthony Gorry and Michael S. Scott Morton, "A Framework for Management Information Systems," Sloan Management Review, v. 13, Fall 1971, page 62.

roughly equals the information on hand. As decisions progress through semi-structured to unstructured, the level of uncertainty increases. The decisions become less defined and makers of these decisions must rely more on personal insight than strict quantitative rules or algorithms. This association between information availability and decision structure is consistent with Galbraith's (1977a, 1977b) contingency theory of management.

The vertical axis of the Gorry and Scott Morton framework represents an organization's hierarchy of managerial activity. This dimension is an adaptation of Anthony's (1965) "Planning and Control Systems: A Framework for Analysis." The three levels (Operational Control, Management Control and Strategic Planning) represent activities sufficiently different in nature to require different information from an MIS. The three levels have already been described in the review of the Anthony (1965) framework.

In Figure 1 on page 12, the area formed by the vertical and horizontal axes represents the domain of management information systems, in an organizational context. This is a slight departure from the Gorry and Scott Morton model in that "MIS" is used as a generic label which encompasses all computer-based information technology processing systems. The bold vertical line separates the regions characterized as structured decision systems (SDS), on the left, from decision support systems (DSS), on the right. The former, SDS, refers to more routine data processing. The more routine the processing, the less decision-making involvement since the decision rules are incorporated into the system software. DSS on the other hand require far greater human involvement and the use of flexible computer-based information technology to support that involvement in the decision-making process.

Some decisions are inherently more structured than others, because information is more available. For example, most budget decisions are based on numerical information that can readily be retrieved and analyzed. Policy decisions, on the other hand, rely on qualitative information which may not exist in the organization's data base. The decision-maker must either go without that information or must develop methods of generating it himself. Managers now have the opportunity to use personal computers to obtain this information, thus providing structure to the decision and reduce the level of uncertainty.[4] However, the fact that the information technology is present or available does not guarantee that the manager will use the technology to his benefit.

[4] Galbraith (1977a, 1977b) defines uncertainty as the deviation between the quantity of information on hand to make a decision and the quantity of information which is necessary to make the decision under fully certain conditions.

The distinctions between the levels of managerial activity are not always clear. However, they can be thought of as paralleling or corresponding to the hierarchical levels of an organization. These levels are: the operational level or operational core; the tactical or middle level; and the strategic level. A primary point of discrimination between these activity levels is the differences in information requirements. The differences in information requirements go beyond simple aggregation of data, to differences in the characteristics of the required information, according to Gorry and Scott Morton (1971: 57). The operational control level requires well-defined information, with a narrow scope and with a short time frame. The strategic level, which is concerned with broad policies and goals, requires more information from external sources in order to monitor the organization's relationship with its environment. The scope and variety of information needed is extensive. Accuracy in data is not strictly enforced. The management control level, between the strategic and operational levels has the broadest range of information requirements.

Much of the theoretical and practical research which has been accomplished has been based on the Gorry and Scott Morton framework (cf. Bennett, 1976; Alter, 1980; Blaylock & Rees, 1984; Keen & Scott Morton, 1978; and Markus & Pfeffer, 1983). The strength of their framework is in its simplicity, its ability to communicate information systems concepts and its ability to suggest new directions for information systems research (Lucas, Clowes and Kaplan, 1974). Additionally, the framework represents information systems in the context of an organization, which is important since these systems are primarily employed in and are central to organizations. For these reasons, this research effort will use the Gorry and Scott Morton framework as the foundation for the development of the information technology user model and hypotheses.[5]

By examining the Gorry and Scott Morton MIS framework and the pertinent literature, the following components were identified:

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[5] There are other frameworks (Gordon & Miller, 1976; Blumenthal, 1969; Dearden, 1965; Forrester, 1961; and Peterson, 1977) which focus on pragmatic aspects of information systems, such as design, development and evaluation. However, they are narrow in scope and do not address the global context in which these systems operate, i.e. the organization. Thus, they were not considered pertinent to this research effort and are not reviewed here. A good overview of most of these frameworks can be found in Lucas, Clowes and Kaplan (1974).

Decision Structure

Information Attributes

Decision Environment

Technology Environment

Individual Perception and Judgment Types

User Sophistication.

These components are discussed in the sections which follow.

Decision Structure

Since Simon's original MIS framework, the concept of decision structure has become a central focus of research in information systems (cf. Keen & Scott Morton, 1978; Dickson, 1984; Carter, 1984; Alter, 1980; Bjorn-Anderson, Eason and Robey, 1986). Simon (1977: 46) describes his ***programmed*** decisions in the following manner:

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

Gorry and Scott Morton (1971) in their framework rename this type of decision "structured." Because of the frequency of occurrence, the necessary information can be predetermined and procedures can be established to handle such decisions. The key to this type of decision is the ease of determining and availability of the required information. Simon (1977) and Galbraith (1977a, 1977b) indicate that a major objective of organizations and managers is to identify the information which is needed to reduced uncertainty and to provide for more structured decisions.

Simon (1977: 46) describes ***nonprogrammed*** decisions in the following fashion:

> "...decisions are nonprogrammed to the extent they are novel, unstructured and usually consequential. There is no cut-and-dry method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex..."

This type of decision requires more involvement on the part of the decision-maker, and there is a great deal more reliance on the heuristic abilities of decision-maker. Subsequent to Simon's (1960) original publication of this concept, Gorry and Scott Morton (1971) use the term "unstructured" to describe these decisions.

In addition to changing Simon's labels Gorry and Scott Morton introduce a new category, 'semi-structured decisions,' which encompasses the grey area between structured and unstructured decisions. The result is a decision structure continuum rather than discrete categories. Unlike other concepts in the information system literature, this taxonomy of decision structure has remained constant though the years. Alter (1980), Bennett (1976), Cheney and Dickson (1982), Daft and MacIntosh (1978), Keen and Scott Morton (1978), Kepner and Tregoe (1981), Kling (1978), Markus (1984), Senn (1981) and others have used this taxonomy, with only minor deviations, to examine, describe, discuss and evaluate the structure of managerial decisions.

Information Attributes

The function of computer information technology, as set forth in the Gorry and Scott Morton framework, is to provide the user (or decision-maker) with information. They describe the quality of such information using different information characteristics or attributes (Gorry & Scott Morton, 1971: 59). The following section reviews the development of the information attribute concept. It focuses on three specific attributes: sufficiency, relevance and reliability.

The concept of information attributes is first mentioned by Howard Snavely (1967) in response to the American Accounting Associates' Committee report: "A Statement of Basic Accounting Theory." Snavely developed a hierarchy of information attributes which was designed to be used for the selection and evaluation of accounting information systems. Attributes were initially applied to accounting information systems, though they have been used subsequently in a much broader range of information system applications. Snavely distinguishes several levels of attributes. **"First-level"** attributes are applicable to all information and application practices. **"Second-level"** attributes are more restrictive in scope, but still retain a wide range of applicability in describing 'useful' information. (Levels three and four are accounting-specific in their description and restrictions.) Information attributes of the first two levels are described below:

1. **First-level Attribute**

- Usefulness - the information makes a contribution toward the goals of our society - its organizations and individual members.

2. **Second-Level Attributes**

- Relevance - the information bears upon or is usefully associated with the actions it is designed to facilitate or the results it is intended to produce.

- Reliability - the information accurately represents the relevant facts, events or entities of what it is purported to portray.

- Sufficiency - the information is of an appropriate quantity and quality to be useful to the user.

- Practicality - the information is worth more than the costs associated with its acquisition and presentation.

The multidimensional conception of information in relation to management information systems was first introduced by Gorry and Scott Morton in 1971. Since then, the attributes developed in Snavely's article have served as a basis for further information-oriented research into the design and evaluation of information systems.

One such information-oriented research effort was conducted by Godfrey and Prince (1971), who used information attributes to develop a model for accounting systems based on an information system perspective.

The attributes of interest in Godfrey and Prince's research are the following:

- Completeness - equivalent to Snavely's 'sufficiency & reliability'
- Relevance - equivalent to Snavely's 'relevance'

Godfrey and Prince's work has two important implications. First, they recognized the importance of the user in information systems. They were early advocates of user-oriented systems with specifications based on user needs. Second, they saw the quality of computer information systems (their ability to satisfy user needs) as a function of the primary users perception of information, in addition to technical aspects of system design (Godfrey & Prince, 1971: 88-89). This study was instrumental in recognizing the importance the user's role in the design and evaluation of information systems.

In 1982 Epstein and King consolidated the works of Snavely, (1976); Godfrey and Prince, (1971); The American Accounting Association's "A Statement of Basic Accounting Theory" (1965); and others into ten "Attributes of Information Value." They empirically studied the value of information at various hierarchical levels of the organization and functional areas. Using the control and operating (Gorry and Scott Morton's management control and operational control) levels of a single site organization, plus marketing, research/engineering and manufacturing areas, they developed a linear model of the value of information. In their research, the participants exhibited no significant differences in the value of information among the three different functional areas or between the two different hierarchical levels.

Three difficulties with the Epstein and King experiment warrant mention. First, they did not take into consideration the decision-making responsibility of the participants. Nor is there any indication of how much each participant used the information system. Therefore, the impact of the decision environment was not completely considered in their study. Second, the information was not identified nor evaluated by the source which generated the information. Thus, the impact of information technology cannot be isolated from that of manual information sources. Epstein and King did not consider in any manner the relationship between information technology and the user's valuation of information. Third, Epstein and King did not consider the influence individual differences might have had on the subjects' assessment of information attributes.

One interesting aspect of the Epstein and King study is that the respondents did not value information differently by level or function. This aspect should be reexamined, however, using a more complete model of the factors which could influence managerial perception of information attributes.

In 1983 King and Epstein developed a linear model of information as an instrument for determining the relative value of an information system. They found an unspecified "high correlation" between results obtained from the linear model they developed and results obtained from managerial evaluations. However, as in their previous study, they did not consider differences in information technology nor differences in individual managers. Therefore, we do not know what part these factors played in King and Epstein's results. As implied in the Gorry and Scott Morton framework, both these components can influence not only decision structure, but also the characteristics of information used in the decision process.

Of all the attributes identified in the MIS literature, sufficiency, relevance and reliability are the ones most often mentioned in relation to management information systems, decision-making, and information theory. Figure 2 on page 20 shows which authors have identified each of the three attributes in their publications.

The definitions which follow were synthesized from the various sources in the literature. They are for the most part consistent with the definitions developed by Epstein and King.

Authors = Information Attributes	1	2	3	4	5	6	7
Sufficiency	X	X	X		X	X	
Reliability	X	X	X	X	X	X	X
Relevance	X	X	X	X	X	X	

Figure 2. Author-Supported Information Attributes: Authors 1 = Snavely (1967), 2 = Godfrey & Prince (1971), 3 = Epstein & King (1982) and King & Epstein (1983), 4 = Burch et al. (1983), 5 = Senn (1982), 6 = Murdick (1980), 7 = Davis & Olson (1985)

Attribute	***Definition***
Sufficiency	the adequacy of the information for the intended purpose.
Reliability	a high correlation between the information and the reality it represents.
Relevance	the applicability of the information to the decision under consideration.

As Duncan (1972: 317) indicated, a lack of sufficient, relevant and reliable information is a major component of 'perceived' decision-making uncertainty. The perceived quality of information not only affects decision-making, but is a key factor in evaluating information systems. Yet, we do not know how individual differences in the users may affect those users' perceptions of the information they receive. This research will attempt to examine this possible relationship.

Next, this review will look at two aspects of the Gorry and Scott Morton MIS framework which have been identified as important to information systems: the decision environment and information technology environment.

Decision Environment

The MIS literature and research has concentrated primarily on macro-level (or organizational) decision-making. For example, the studies of Winner (1977) and Whisler (1970a) do not even address the concept of a user's decision environment. However, Duncan (1972),[6] in a theoretical work on organizational environments, proposes three dimensions to a decision environment. These are:

- Personal - The individual qualities of the decision-maker, including technical skills and behavioral types.

- Organizational Level - The managerial level of the decision-maker in the organization.

- Unit Decisions - The type of organizational unit (i.e. accounting, personnel) determines the category of decisions which are to be made. This translates into what Cheney and Dickson (1982) posit "decision categories" or major classes of decisions, which vary according to the organizational unit. However, Sackman (1972) indicates that there are major classes of decisions which are applicable regardless of the type of unit in the organization.

The implication is that these three factors constitute the decision environment at an individual level of analysis.[7] Most other discussions of information system decision environments have focused at the macro-level and are not relevant to this endeavor (cf. Huber, 1984; Kahn, Brown & Martel, 1976; Daft, 1982; and Daft & Lengle, 1984).

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[6] Since this research has focused on the individual level of analysis Duncan's "internal decision environment" is being referred to here. His meta-level environment is not the point of analysis or consideration. Duncan's "external environment" mainly refers to the social, physical and political facets of factors which are outside the organizational boundaries and are predominately issues for the strategic level of the organization.

[7] This concept of a decision environment has been supported by Cheney and Dickson (1982) and Franz and Robey (1986).

The personal or individual dimension will be discussed later in this chapter. This aspect has been separated since the qualities of the individual manager, at this level of analysis, produce a construct which is independent of Duncan's decision environment. The other two factors, organizational level and unit decisions, are discussed below.

One difficulty in looking at an organizational level is to successfully identify the level of the individual under consideration. By way of a very general definition, middle managers or managers at the Management Control level[8] are responsible for coordination, communication, and implementation of specific strategic objectives. Their duties include information gathering, monitoring and generation functions within the organization. They channel information throughout all levels and boundaries of their organizational unit.

The first issue for a researcher is how to specifically define and locate "middle managers". When one examines the literature and text on general management, it becomes obvious that there is no clear and succinct definition of these managers. Most authors have done this by using a list of specific criteria. Based on a review of Duncan (1983), Anderson (1984), Mescon, Albert and Khedouri (1985), Hitt, Middlemist and Mathis (1986), Steers (1981) and Litterer (1978), the following list was complied of the descriptive statements most often used to describe middle managers. This list will be used in Chapter 3 as a basis for subject identification. The statements are not listed in any particular order.

A MIDDLE MANAGER :

1. has advanced at least two levels in the organization's structure,
2. is in charge of or responsible for a sub-unit or department within the organization,
3. performs a "buffering" function between top management and supervisory management,
4. has, as immediate subordinates, individuals with supervisory responsibility,

[8] This discussion will focus on the management control level (or middle management) only. The reasons for this focus will be discussed in detail in the methodology chapter.

5. interacts indirectly with non-managerial employees through supervisors,
6. has task functions which include coordination, planning, information processing and monitoring,
7. has the authority to implement change(s) in the sub-unit or department,
8. has the authority to discharge employees in the sub-unit,
9. has the authority to hire new employees in the sub-unit, and/or
10. has reporting responsibility to vice president or other division (group) executives.

It is clear from this list that identification of middle managers is very organization-specific and can be difficult. However, we will operationalize this concept in Chapter 3.

Duncan's last dimension of a decision environment, the categorization of major decisions, presents a similar difficulty: how to identify categories which are general enough to cover most possible decision situations, yet not so nebulous that they encompass too many situations and lose their meaning. A review of the literature and leading texts in general management (Duncan, 1983; Anderson, 1984; Mescon, Albert & Khedouri, 1985; Hitt, Middlemist & Mathis, 1986; Steers, 1981; and Litterer, 1978) yielded the following composite list of decision categories:

- Policy
- Budget/Finance
- Staff/Personnel
- Resources
- Administration

Generally decisions can be categorized according to one of these labels.

Information Technology Environment

The Gorry and Scott Morton (1971) framework is based on the use of information technology to support decision-making in organizations. In the 1960's and early 1970's "information technology" was relatively easy to describe; it consisted of centralized mainframe computer systems, which operated in either a batch or timesharing mode. However, rapid technological advances and the introduction of microcomputers in the early 1980's have radically changed the information technology environment. Now a wide variety of computers, computer systems, software systems and communication connections are available. Empirical research efforts thus far have considered the presence or absence of computer-based technology, but have not differentiated between different kinds of technology environments. As late as 1986, Bjorn-Anderson, Eason, and Robey acknowledged the possibility of differences in information technology environments; however, they elected not to consider the possible influence of such differences on the observed results.

In addition to its changing nature, a second important aspect of the information technology environment is that it has become an individual-level phenomenon. Most organizations still provide some sort of centralized computing facility, with access to local and wide-area networks and mainframe capability. However, with the current trends in cost and capability, users can economically supplement organizational hardware and software. Thus, the information technology environment may be significantly different for different users within the same organization.

In the absence of previous empirical research to distinguish information technology environments, the following construct is offered. Davis and Olson (1985: 21), suggested that the "technology environment" of management information systems consists of "hardware, software and communications facilities." The division of information technology into these components is supported by other authors (cf. Senn, 1982; Pressman, 1982; and Dickson & Wetherbe, 1985). Davis and Olson discuss these principal areas in their text. However, the MIS literature has yet to develop procedures for examining these components. The following discussion will show the emergence of these three facets as information technology has developed.

The use of information technology in organizations has increased dramatically in recent years. Guimaraea and Ramanujam (1986) report that the proportion of Fortune 500 companies using personal computers increased from 8% in 1980 to 100% in 1984. The configurations of hardware now available range from very sophisticated supercomputers to stand-alone, desktop microcomputers. The biggest growth has occurred in the microcomputer market. From 1951 (when UNIVAC I appeared) to 1980, an estimated 1 million computers were manufactured. In contrast, the sales of microcomputers alone for the years 1983, 1984 and 1985 exceeded 1 1/2 million units. Dataquest, Inc. (1981) estimates that within four years the sales of microcomputers will exceed 11 million units annually. Clearly the use of information technology has become a dominant feature of corporate America.

In a study of computer and software use, Frand and McLean (1986) surveyed 241 members of the American Assembly of Collegiate Schools of Business (AACSB) to identify the computer information technology used to support administration, as well as educational programs. Their survey identified 102 different types of computers, 61 different types of communications networks, and 169 types of software packages which were being utilized. The software packages included:

word processing systems,
spreadsheet analysis systems,
data base management systems,
statistical and mathematical modeling systems, and
programming languages.

This wide variety of hardware, software and communication systems was found in a single setting, i.e. university business colleges, and does not include more technically sophisticated systems and packages which may be used in the physical sciences.

There has also been a significant growth in computer networks through the use of telecommunications technology. The following is a very small sampling of the computer networks currently operating:

- CSNET (Computer Science Network)
- BITNET (Because Its Time Network)
- DDN (Defense Data Network)
- ARPANET (Advanced Research Projects Agency Network)
- Dow (Dow Jones and Business Information Network)
- TRANET (Transaction Network for Appropriate Alternative Technologies)
- BIX (Byte Information)

This list does not include the local area networks (LAN), such networks are based on protocols like DEC's ethernet and IBM's token ring, which have been developed within organizations or small business units to support internal computer communications and electronic mail systems. Many of these local area networks have gateways which allow users to access one or more wide-area networks. As an example of a local area network, IBM operates in Europe an internal network with over 50,000 nodes.[9] The combination of these internal and external computer networks give managers a formidable communication system for sending, accessing and retrieving critical information, as well as a highly expeditious mail system.

From this discussion one can see that the concept of the information technology environment is complex. Organizations are providing the higher level computing resources; i.e. mainframes, major software licensing and networks. However, with the low cost of hardware and software, users can augment organizational systems and tailor the information technology environment to their individual needs. Thus, the environment must be defined in terms of the ***hardware, software and com-***

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[9] A node is a point on the network where a computer host, microcomputer terminal or terminal cluster is attached to the network.

munication dimensions. These relate to the technology configuration of the features which are available at the level of the individual user.

The following portion of this review will address two aspects of user individuality: psychological type and user sophistication. These aspects represent what Duncan (1972) calls the personal dimension of a decision environment.

Individual Perception and Judgment Types

Since Mason and Mitroff's 1973 publication on MIS research, the topic of psychological or cognitive types has appeared in the literature with increasing frequency. With minor exceptions (such as Doktor and Bloom's (1972) Left and Right Brain analysis, and Driver and Mock's Decision Style Theory), the primary focus has been on Jungian typology. There are two important reasons for this. First, the Jungian typology was cited by Mason and Mitroff in A Program for Research in Management Information Systems (1973) as the "most suggestive" typology for research purposes. Second, the Jungian typology does not advocate one psychological type over another. Each of the four basic types or modes had its own unique qualities, strengths and weaknesses.

Jungian typology has been used primarily in pure decision theory (not specifically related to information technology) or in information system design (cf. Mason & Mitroff, 1971; Henderson & Nutt, 1980; Zmud, 1979; Lucas, 1975; McGee, Shield & Birnberg, 1978; and Blaylock & Rees, 1984). This research effort will use Jungian typology to examine cognitive differences among information system users. It has been suggested in the literature (Zmud, 1979; and McGee, Shield & Birnberg, 1978) that differences in cognitive types could result in different information requirements, though there is no specific empirical evidence for this theory. In the present research effort, which will examine the effect of user sophistication on decision structure and information attributes, it is necessary to determine what portion of the variation is due to cognitive differences among individual. In this way the differences which are directly attributable to user sophistication can be isolated.

In the Jungian typology individuals differ in two major mental functions: perception and judgment. These functions describe the way an individual acquires and internally processes information.

Perception is the way individuals acquire information from the outside world. It is the process by which they become aware of ideas, facts, events and other individuals. The perception process is divided into two types: Sensing and Intuitive. (As with any typology, individuals will vary in degree between these extremes.) Sensing individuals rely on their human senses to acquire information. They prefer to collect information and facts by sight, smell, sound, taste and touch. They have a preference for facts and details. Conversely, Intuitive individuals see the totality of a situation and look beyond the facts to acquire conceptual and situational information. Theirs is a more indirect perception, which incorporates or associates additional meaning to perceptions from the outside world.

Judgment refers to the way in which an individual internally processes information in order to arrive at a conclusion. The judgment process is divided into Thinking and Feeling types. Thinking types process information logically and impersonally to arrive at a finding consistent with the given information. Information is highly discriminated. Feeling, types are more subjective and rely on affective processes. These individuals value information according to subjective likes and dislikes.

These two independent dimensions can be combined to form four distinct cognitive types. These type combinations are listed below, with a brief description derived from Myers (1984: 5-6):

- Sensing Thinking (ST) "...their main interest focuses upon facts, because facts can be collected and verified directly by the senses ... [They] approach their decisions regarding these facts by impersonal analysis, because of their trust in thinking, with its step-by-step logical process."

- Sensing Feeling (SF) "...approach decisions with personal warmth, because their feeling weights how much this matter to themselves and others. [They] are more interested in facts about people than in facts about things."

- Intuitive Feeling (NF) "...they do not center their attention upon the concrete situation. Instead they focus on possibilities, such as new projects ... or new truths. [They] are both enthusiastic and insightful."

- Intuitive Thinking (NT) "...they focus on possibility, they approach it with impersonal analysis. Often they choose a theoretical or executive possibility and subordinate the human element. [They] tend to be logical and ingenious and are most successful in solving problems... " They are technically oriented and interested in computers and technology (Myers, 1984: 6).

Previous research has suggested that these cognitive types will influence the perceived decision structure and information preference (Blaylock & Rees, 1984; Mason & Mitroff, 1973; and Henderson & Nutt, 1980). Therefore, in looking at the relationships between user sophistication, and decision structure and information attributes, consideration must be given to the impact or moderating influence the user's perception and judgment will have on those relationships.

This completes the discussion of the three dimensions of Duncan's decision environment. Next, the principle focus of this research, user sophistication will be reviewed.

User Sophistication

The Gorry and Scott Morton framework (1971) identifies three principal components of a management information system: the organization, the technology and the user. The organizational and technological aspects are discussed above. The cognitive aspects of the user have also been reviewed. The last component to be considered in this chapter is user sophistication.

Past research on the impact of computer-based information technology has considered only two groups of individuals: users and non-users (cf. Whisler, 1970; Winner, 1977; Robey, 1983; Foster & Flynn, 1984; and Bjorn-Anderson, Eason & Robey, 1986). However, the growing complexity and variety of information technology has created reasonable doubts as to the validity of such a polarized image of users. A key premise of this study is that homogeneous user populations no longer exist. Differing technological environments require widely differing levels of user sophistication.

In 1980, Cheney and Lyons conducted a survey which examined the differences in information technology skills required in industry. They identified 26 distinct areas including such topics as: telecommunication concepts, sorting, hardware characteristics, software capability, file design and file configuration. The Frand and McLean (1986) study mentioned in a previous section identified 102 different computers, 61 networks and 169 software systems in a single type of business unit. The implication is that managers who avail themselves of information technology, even within the same organization or type business, may possess very different levels of user sophistication. The following discussion will show that users differ in both the pattern of information technology usage and in the level of knowledge/understanding which facilitates that usage.

The literature in this area is very sparse. The first study, in 1979, by the Codasyl End-User Facilities Committee, introduced a classification system which identified the following classes of users:

1. Indirect Users - Individuals who must go to a third party in order to obtain information.

2. Intermediate Users - Individuals who are sufficiently knowledgeable to specify their information needs to a direct user.

3. Direct Users - Individuals who personally interface with the computer (i.e. actually perform key stroke operations at a terminal).

This classification was an attempt to identify the differences in computer usage which were emerging at the time. However, the last classification, direct users, is not sufficiently discriminatory for today's users. Since 1980, the growth of microcomputers has increased the number of direct users by at least an order of magnitude. With a user population of 10 million (Naisbitt, 1982), different usage patterns and levels of understanding/knowledge are inevitable.

In a more recent publication, Rockart and Flannery (1983) recognized the difficulty with aggregating such a significant portion of the user population into the single category, direct users. They further divided the direct user class into four major types of direct users. The differences in the user population were derived from a case study of three commercial industries, which looked at two factors:

- computer usage and access patterns, and

- numbers and types of software packages and systems used.

Rockart and Flannery (1979: 778) developed the following direct user taxonomy as a result of their research efforts. This taxonomy echoes a similar division of users developed by Keen and Scott Morton (1978).

- Nonprogramming end-users (those who only access computer stored data through the software provided by others.)

- Command level users (those who have a need to access data on their own terminals. They perform simple inquiries, often with a few simple calculations such as summation, allowing them to generate unique reports for their own purposes.)

- End user programmers (those who utilize both command and procedural languages[10] for their own personal information needs.)

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[10] Command languages are those where the user enters a command, maybe with an argument to invoke an operational response from a computer. Procedural languages are those which are commonly associated with programming such as FORTRAN or COBOL.

- Functional support personnel (sophisticated programmers who support other end-users within their particular functional area. These individuals, by virtue of their prowess in end-user languages, have become informal centers of systems design and programming expertise within their functional area.)

Clearly, with the growing number of users and their associated information technology environments, researchers can no longer assume that all computer information technology users are equally sophisticated.

This research effort proposes that users differ in both their usage patterns and their level of information technology knowledge or familiarity. These factors are what Duncan (1972: 315) calls "technological background and skills" of the individual manager. These two dimensions are important in identifying an information technology user's level of sophistication.

The preceding discussion and review of the literature has presented the building blocks of a model of the information technology user. In the next section, this model is developed, and research hypotheses based on the model are presented.

Conceptual Model of The Information Technology User

This section will develop a model of the information technology user which is consistent with the Gorry and Scott Morton framework. This model will place the possible relationships which have been identified in the literature review into a model which examines the factors at work at the user level of computing.

The dependent factors in this model are decision structure and decision-related information attributes. Cheney and Dickson (1978) empirically demonstrated that the implementation of information technology does influence the structure of decisions made. Their study, which looked at the introduction of computers in eight unspecified Minneapolis/St. Paul firms, determined that "installing Computer-Based Information Technology will increase the degree to which decisions are programmed (Structured) within the user's area." (Cheney and Dickson, 1982: 179.) However, this study did not consider the impact of other factors, beyond the presence of the technology, on the observed variance. The dependent variables which will be tested using the Information Technology User Model are: (1) decision structure; and (2) information attributes (sufficiency, relevance, and reliability). These have been used before as dependent variables in MIS research (Cheney & Dickson, 1978; King & Epstein, 1983; and Epstein & King, 1982). However, by use of a multivariate model these variables can be examined in a method which will consider the influence of more than one independent variable.

The Information Technology User Model looks at the differences in users within the context of their organizational environment. The primary independent variable is user sophistication, which is composed of two components: the user's computer usage pattern (Keen & Scott Morton, 1978; and Rockart & Flannery, 1983) and the user's level of computer literacy (Duncan, 1972). This latter component, thought not explicitly stipulated in the literature, is a logical implication of that literature. Gorry & Scott Morton (1971), Olson & Lucas (1982), Lucas (1982), and Markus (1986) state that the influence of computer technology is achieved in part through the utilization of that technology. Additionally, Duncan (1972) indicates that decision-maker's information-processing understanding and skills played an important part in the overall decision process. Therefore, user sophistication incorporates a measure of the user's level of understanding, which has been labeled "literacy" in this study.

Besides looking at the above independent variable and dependent variables listed above, the model must consider the other factors which have been identified as possible causes of variation in the dependent variables; namely Decision Environment; Information Technology Environment and Individual Perception and Judgment Type. Only by considering all these variables can the influence of user sophistication be isolated.

Individual perception and judgment types reflect the user's perception process, which is used to acquire information, and the user's judgment process, which is used to discriminate and evaluate information (cf. Simon, 1960; Jung, 1970; Pratt, 1980; and Blaylock & Rees, 1984). Other research has indicated that individual differences in perception and judgment influence the structure of decisions (Blaylock & Rees, 1984; Mason & Mitroff, 1973; and Miller & Gordon, 1975).

In addition to considering the user's technical characteristics as well as the user's psychological differences, the model must account for the differences in the Information Technology and the Decision Environments (Gorry & Scott Morton, 1971; Simon, 1960; Keen & Scott Morton, 1987). The reason for this is that the literature reviewed has indicated that these factors potentially can influence both the decision structure and the attributes of information used in the decision process. Thus, to determine the significance of user sophistication in relation to decision structure and information attributes, the model must incorporate both the user's information technology environment and user's decision environments in the user's model (Gorry & Scott Morton, 1971; Keen & Scott Morton, 1978; and Blaylock & Rees, 1984).

Definitions

Based on the previous discussions, the dependent and independent variables in the Information Technology User Model are listed and defined below.

VARIABLE	DEFINITION
The first four definitions refer to the dependent variables in the model.	
Decision Structure	Decision Structure is a continuum of decisions anchored by structured and unstructured decisions, as defined by Simon (1977).

Information Attribute: Reliability	The information can be relied upon to represent the facts, events or entities of which it is purported to represent.
Information Attribute: Sufficiency	The completeness or fullness of the information with respect to its ability to meet the decision makers information requirements.
Information Attribute: Relevance	The information is generally, completely applicable to the decision situation making a contribution to the decision process.

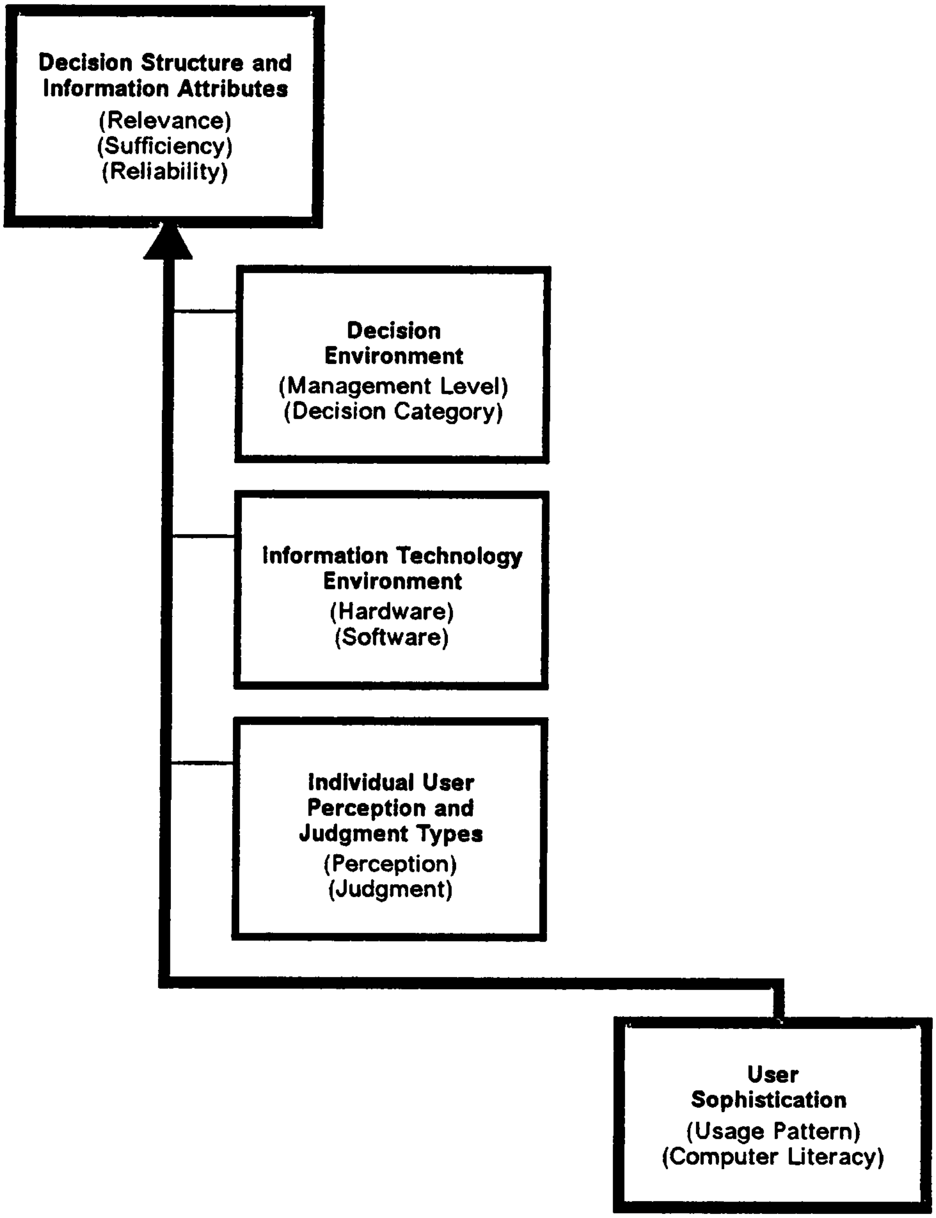
The next four definitions refer to the control and independent variables in this research endeavor.

Decision Environment	Decision Environment represents the manager's level of managerial activity and major categories of decisions being made.
Information Technology Environment	The hardware and software configuration of the user's computer technology working environment.
Individual Perception and Judgment Types	The user's information acquisition (perception) and information processing (judgment) mental functions.
User Sophistication	The user's pattern of information technology usage and computer familiarity (literacy) with the terminology associated with computer information technology.

Figure 3. A Conceptual Model of the Information Technology User

Decision Structure & Information Attributes = a function of [

1. Decision Environment
2. Information Technology Environment
3. Individual User Perception and Judgment Types
4. User Sophistication (Computer Usage + Computer Literacy)]



Model

These variables have been arranged in a graphical model (Figure 3 on page 36), which represents the user in the context of an organization. This research model has been titled the Information Technology User Model. The top block represents the dependent variables: Decision Structure, Information Relevance, Information Sufficiency, and Information Reliability. The bold arrow represents the relationship between the dependent variables and the independent variable, User Sophistication. This relationship is the focus of this research endeavor.

The three intermediate blocks represent independent variables which the literature has indicated may affect the relationship between the dependent variables and User Sophistication. For reasons of completeness these variables (Decision Environment, Information Technology Environment, and Individual User Perception and Judgment Types)[11] must be included for an accurate and complete account of the effects at work. Thus, this model takes a composite look at information attributes and decision structure. These two factors have been the focus of much discussion in the information systems literature, but unlike previous research, this model looks at these dependent variables as the result of several factors as opposed to just one. These control variables (see footnote) have been theoretically discussed or empirically examined in relation to the dependent variables. The lines connecting the control variables to the main bold arrow (Figure 3 on page 36) indicate that these variable may influence the relationship between the dependent variables and User Sophistication.

This model makes three positive contributions. First, it attempts to examine the significance of the individual user in information system research. Second, it does not look at these systems in isolation, but rather attempts to bring together other factors which could explain observed variance in

[11] These three variables are considered 'control' variables: i.e. they will either be measured and statistically held constant in order to test the relationships between the dependent and independent variables or else by design the variables will be held constant across all subjects in the experiment. Thus, any observed variance can be attributed to the independent variable.

the dependent variable. Third, it provides a starting point for future discussion and research regarding the changing dimensions of information technology from an individual level of analysis.

The last section of this chapter presents the hypotheses which have been developed to examine the relationship between the dependent variables and user sophistication.

Hypotheses

In the Information Technology User Model the bold arrow indicates the relationship which is the primary focus of this research. Four research hypotheses have been proposed based on this model. They deal with the relationship between the dependent variables and user sophistication and are listed below:

1. The level of managerial users' sophistication is positively related to their level of structured decisions, after controlling for Decision Environment, Information Technology Environment, and Individual User Perception and Judgment Types.

   Discussion: Galbraith's (1977a, 1977b) contingency theory of management uses an information approach to focus on management activities. According to Galbraith's framework, decision structure is a function of uncertainty or a lack of information on which to base decisions. Gorry and Scott Morton (1971), as did Galbraith, prescribe information systems as a means of providing necessary information to managers. Today, with a 92 percent increase from 1980 to 1984 in the use of computers by the Fortune 500 companies (Guimaraea & Ramanujam, 1986), there is a significant reliance on computer information technology in business. Previous information systems research has attributed the increase in structured decisions solely to the installation of the technology (Cheney & Dickson, 1978). However, this hypothesis is aimed at identifying a relationship between levels of decision structure and levels of user sophistication. In any given decision situation a manager with a high level of user sophistication, can use the technology to obtain critical information with which to structure the decision.

2. The level of managerial users' sophistication is positively related to their perceived level of decision information relevance, after controlling for Decision Environment, Information Technology Environment, and Individual User Perception and Judgment Types.

Discussion: One point omitted in Galbraith's (1977a, 1977b) treatment of decision structure and integrated computer information systems is an examination of critical information characteristics. The availability of information does not automatically provide support for a decision (or a decision-maker). The information must possess characteristics such that it will be of benefit to the user (Snavely, 1976). Gorry and Scott Morton (1971), Snavely (1967), and Godfrey and Price (1971) used information attribute theory to describe such beneficial qualities in information. (The theory states that information must be useful in order to make a contribution. This usefulness is measured by multidimensional attributes or characteristics of information.) This hypotheses and the two which follow focus on the relationship between a user's sophistication and the user's ability to isolate or obtain information which is important to the decision-making process. The first information attribute is relevance. Relevance is defined as the degree to which information is applicable to or contributes to the decision situation. The information to be useful must bear upon or be associated with the problem, problem analysis, or decision process. Previous empirical research by King and Epstein did not consider any environmental or technological factors in their look at information attributes. Nor did they look at the individual with respect to his ability to manipulate the mechanisms through which he acquired information. This hypothesis is aimed at identifying a relationship between degree of information relevance and levels of user sophistication, while considering environmental and technical factors, as well as the source of the information. Hypothetically, a manager with a high level of user sophistication is able to acquire the information which is relevant to his decisions.

3. The level of managerial users' sophistication is positively related to their perceived level of decision information reliability, after controlling for Decision Environment, Information Technology Environment, and Individual User Perception and Judgment Types.

Discussion: Similar to the previous hypothesis, this one looks at a second dimension of information provided through information technology. In this case reliability is defined as the degree to which the information can be depended upon by the decision-maker. The information must be an accurate representation of the facts, events or entities of which it is purported to represent in order to be useful in the decision process. King and Epstein did not consider any environmental or technological factors in their look at information reliability. Absent from their model was a consideration of the manager's ability to distinguish sources of information, and the impact the information source would have on the manager's assessment of the information's reliability. This hypothesis is aimed at identifying a relationship between levels of information reliability and levels of user sophistication, while considering environmental and technical factors, as well as the source of the information. Theoretically, managers with a high level of user sophistication have the understanding or knowledge which will enable them to assess the reliability of the information they receive from their information technology sources.

4. The level of managerial users' sophistication is positively related to their perceived level of information sufficiency, after controlling for Decision Environment, Information Technology Environment and Individual User Perception and Judgment Types.

Discussion: This last hypothesis looks at the relationship between user sophistication and a third information attribute, the sufficiency of the decision information. Sufficiency is defined as the completeness of the information. In other words, does the information meet the user's requirements and provide a complete description of the decision situation? Previous empirical research by King and Epstein did not consider any environmental or technological factors in their look at information value. Nor did they look at the individual with respect to his ability to manipulate the information system to acquired sufficient information. Sufficiency, however is not synonymous with volume. If one is able to understand and manipulate an information source, one can isolate and acquire that portion of the information which is needed. This quantity could be much less than that produced by 'standard' types of information-generating systems. Theoretically, a manager with a high level of user sophistication is better able to manipulate his information system to acquire or generate the information he needs.

Remarks: Using the Information Technology User Model, one could hypothesize additional relationships between the control variables or between the control variables and the independent variable. The difficulty at present is that the MIS literature does not directly support formulation of these hypotheses. Nevertheless, the following relationships between variables have been tested for statistical significance.

1. User Sophistication and Information Technology Environment (i.e., more sophisticated users will develop more sophisticated information technology environments to support their computing needs),
2. User Sophistication and Individual User Perception & Judgment Types (i.e., certain psychological types will develop greater technical sophistication to support inherent information processing needs), and
3. Information Technology Environment and Individual User Perception & Judgment Types (i.e., certain psychological types will be naturally attracted to more technical aspects of information technology, thus developing more sophisticated environments.)

These relationships have been tested to insure that excessive multicollinearity does not exist between the control and the independent variables. (Multicollinearity, a statistical phenomenon, will be explained in the next chapter.) In addition to affecting a regression analysis, a strong correlation between these variables could produce a moderating effect on the relationship between user sophistication and the dependent variables.[12]

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[12] Moderating variables can change either the strength or form of the relationship under analysis (Sharma, Durand and Gur-Arie, 1981).

The next chapter describes the procedures and research methods which were employed to test the research hypotheses listed above.

Chapter 3: Methodology

The purpose of this chapter is to outline the procedures and methods which have been developed to test the four research hypotheses presented in Chapter Two. Three areas of methodology are addressed: the population and sites used in the study, the procedures employed in data collection, and the instruments generated to collect that data. The last section of the chapter outlines the statistical methods employed to test the hypotheses and the pre-test analysis.

Population

The population for this research is middle level managers/administrators in two academic institutions. One of these institutions is located in the northeast United States and one is located in the Mid-Atlantic region. Both institutions requested anonymity as a condition of their participation in the study.

The rationale for this selection of population and sites was as follows:

- First, middle level managers have a wide mix of decisions from structured to unstructured (Simon, 1973; Gorry & Scott Morton, 1971; Lucas, 1979; Kurstedt, 1986a). Lower levels of organizations are normally dominated by structured decision, while upper levels are dominated by highly unstructured decisions. Focusing on the middle level provides an opportunity to sample managers with a decision structure which is theoretically distributed across the entire range. This same rationale applies to information attributes. According to Gorry and Scott Morton (1971), information characteristics change according to the level of the organization. Middle managers theoretically requires information clustered around the center of any given attribute range, with deviations toward the high and low ends of the range. Thus, they provide an ideal population for hypothesis testing at the individual level of analysis.

- Second, middle management has proven to be the most open to the influence of information technology (Whisler, 1970; Simon, 1973; and Cheney & Dickson, 1978). (The reason for this openness to the influence of information technology has yet to be determined empirically.) Thus, if the relationships under analysis do exist, they are most likely to show up in middle managers.

- Third, use of managers within the same 'industry' attempts to minimize the variance due to contextual issues within and between the organizations involved in the study. All academic institutions focus on the same general areas, i.e. administrative matters, students, faculty, staff, resource allocation, curriculum and budgetary problems. Additionally, academic institutions provide sites where the organizational structure is relatively more traditional and less complicated. In other words, compared to a multi-level conglomerate, or a multinational corporation, academic institutions have a clearer definition of levels within the institutions.

- Fourth, in the Gorry and Scott Morton (1971) MIS model, the organizational decision environment is a function of the type of decisions being made, the information technology, and the level of the decision-maker in the organization. By controlling for the level of the organization, the category of decisions, and the information technology, emphasis can be placed on isolating the effects of the user sophistication.

- Fifth, academic institutions are and have historically been aware of the importance of information technology. They are normally dedicated, within organizational constraints, to providing the institution and its members with state-of-the-art technology. These types of organizations provide a wide range of information technology. Hypothetically, this wide variety of technology has also produced a population of users with an equally wide range of user sophistication.

Based on the criteria reviewed in the previous chapter, the middle managers identified as subjects for this research are:

1. university deans
2. associate deans
3. department heads
4. directors of academic centers
5. university position grades equivalent to 1 thru 4 above.

This subject selection was made in cooperation with a representative from Institutional Research at each of the research sites.

The research sites were selected based on five criteria:

- access to a broad range of computer-based information technology,
- availability of identified subjects,
- comparatively equal range of academic disciplines
- willingness to participate in the study, and
- roughly equal staff and faculty size.

Data Collection

The data for this dissertation were collected through a mail-back survey. After the survey was piloted and compiled in its final form, copies of the survey were mailed to the institution's point of contact and then distributed by internal campus mail. All individuals at the sites who fit the research subject specifications were surveyed. The surveys from both universities were returned, by self-addressed, stamped envelope to the Management Department at Virginia Polytechnic Institute and State University.

The sample size by institution is listed below. Following the size is the response rate anticipated by the points of contact.

1. Mid-Atlantic academic institution: - N = 200; with 60% to 70% response rate anticipated

2. Northeastern academic institution: - N = 200; with 50% to 60% response rate anticipated

3. Total population size = 400

Measurement of Constructs

This section describes the instruments which were designed to measure the variables in the Information Technology User Model. In the development of the instruments, the following aspects were considered and incorporated to improve the final response rate. The ideas were generated from Dillman's (1978) work on designing mail surveys.

- Develop the instrument in a manner that leads the participant from the simple beginning to progressively more difficult portions.

- Carefully select the first question, which will set the subject's mood for the remainder of the responses and may in fact determine whether the survey is to be ultimately completed.
- Provide the subject with simple directions on how to answer the questions, i.e. minimize the mental effort necessary to complete the survey.
- Use multiple columns to conserve space and present a more professional appearance to the recipient.
- Insure the respondent that her or his confidentiality will be maintained.
- Provide a cover letter which explains the purpose of the study, stressing its usefulness and offering to provide feedback on request.

The instruments were pilot-tested three times. The first pilot focused on the User Sophistication and Information Technology Environment items. The second pilot added the items from the dependent variables Decision Structure and the Information Attributes. In addition, it examined the scoring scheme for the computer literacy portion of User Sophistication. The third and last pilot tested the full survey. This refinement process identified the items within the instruments which would produce the most reliable and valid results. The resulting instruments are described in the following subsections.

Decision Structure

In the Information Technology User Model, decision structure was defined as the frequency of occurrence, ability to be numerically analyzed and the level of uncertainty in the decision situation. To measure this concept an ordinal scale modified from the work of Epstein and King (1982) was used. This was a 0 to 100 percent scale on which the subjects were asked to indicate a level of decision structure for general categories of decisions which they encountered. The 100% end of the scale was anchored by 'Structured' and the 0% end by 'Unstructured'. Definitions were provided for each anchor, which were consistent with Simon's (1965) definitions and others (cf. Alter, 1980; Bennett, 1976; and Murdick, 1980).

This method of measuring decision structure was used by Cheney and Dickson (1982). However, they used a seven point Likert scale which ranged from programmed to nonprogrammed decisions. The labels were changed to 'structured' and 'unstructured' in order to make the anchors more consistent with information systems terminology and the Gorry and Scott Morton framework. The definition used here and in Cheney and Dickson was the same. The 100 point scale was used to provide subjects with an opportunity to express greater variation in their responses. The ordinal scales developed by King and Epstein (1983) demonstrated an ability to identify such variation. Following the third pilot, the General Form of the Spearman-Brown Prophecy formula measured reliability as .8436. This shows that there was a high degree of internal consistency within the instrument.[13]

The instrument is presented below:

Please indicate, with an 'X', on the following scales the degree to which your decisions, for the identified category, are structured. At '0%', they are totally unstructured; at '100%' they are totally structured according to the following definition.

Structured Decisions: i.e., decisions which are made on a routine basis and can be reduced to a high level of numerical analysis.

Unstructured Decisions: i.e., decisions which are normally one of a kind or which occur very infrequently and involve a great deal of uncertainty.

13

To estimate reliability the General form of the Spearman-Brown Prophecy Formula is being used in this study (Nunnally, 1978; Kerlinger, 1973; and Carmines and Zeller, 1979). Spearman-Brown's formula is often referred to as a reliability 'coefficient alpha'. It measures the commonality of the instrument's items or their internal consistency. Simply put, various items in the instrument must measure the same thing. The coefficient alpha establishes an upper limit to the reliability of the test or instrument. This reliability is determined by the intercorrelation of items and the number of items in the particular test (Nunnally, 1978). Thus the primary factor in determining reliability is the intercorrelation between items. The greater the strength of the associations or correlations among questions, the greater the estimate of reliability. A more detailed discussion of the derivation of the Spearman-Brown Prophecy Formula can be obtained from Nunnally (1978).

MY DECISIONS IN ......

...Budget Forecasting are...

0% 10 20 30 40 50 60 70 80 90 100%
Unstructured Structured

...Budget Monitoring are...

0% 10 20 30 40 50 60 70 80 90 100%
Unstructured Structured

...Policy Administration are...

0% 10 20 30 40 50 60 70 80 90 100%
Unstructured Structured

...Staff and Faculty Administration are...

0% 10 20 30 40 50 60 70 80 90 100%
Unstructured Structured

...Resource Allocation are...

0% 10 20 30 40 50 60 70 80 90 100%
Unstructured Structured

The scores from each of the responses were added to form a composite value for decision structure and averaged over the number of responses to determine a variable value ranging from 0 to 100. This method of scoring is consistent with the research cited above.

Information Attributes

The Information Attributes were measured using an ordinal scale developed by Epstein and King in 1982. As mentioned before, the information attributes of interest in this study were sufficiency, reliability and relevance. The variable was measured with a 0 to 100 point scale on which the subject was asked to indicate the degree to which a particular attribute described the information received from information technology. Each end of the scale was anchored by an extreme of the particular attribute. For example for the attribute of sufficiency, the 0 end was anchored by 'Not Sufficient' and the 100 end by 'Completely Sufficient.'

Epstein and King (1982) used this type of scale on two occasions (King & Epstein, 1983) with good results. These are the only studies in the MIS literature in which information attributes were measured. The concept of information attributes in MIS was proposed by Gorry and Scott Morton (1971) and these particular attributes are consistent with the conceptual intent of that framework.

Following the third pilot of the survey, the following reliability coefficient alphas were computed:

- Sufficiency - coefficient alpha = .9487
- Reliability - coefficient alpha = .9706
- Relevance - coefficient alpha = .9660

That portion of the survey which measures these information attributes is shown below:

Please indicate, with an 'X', on the following scales the degree to which the information attributes (defined below) describe the information you receive from computer information technology.

...**Sufficient:** i.e. is complete and full, and meets your decision-making information requirements.

...**Reliable** i.e. can be relied upon to represent the facts, events or entities which it is purported to represent.

...**Relevance:** i.e. is generally, completely applicable to your decision process and makes a contribution to that process.

THE INFORMATION I RECEIVE FROM COMPUTER INFORMATION TECHNOLOGY TO SUPPORT...

...Forecasting Budgets is...

1. **...Sufficient:**

0 10 20 30 40 50 60 70 80 90 100

Not Sufficient — Completely Sufficient

2. **...Reliable:**

0 10 20 30 40 50 60 70 80 90 100

Not Reliable — Completely Reliable

3. **...Relevant:**

0 10 20 30 40 50 60 70 80 90 100

Not Relevant — Completely Relevant

...Budget Monitoring is...

4. **...Sufficient:**

0 10 20 30 40 50 60 70 80 90 100

Not Sufficient — Completely Sufficient

5. **...Reliable:**

0 10 20 30 40 50 60 70 80 90 100

Not Reliable — Completely Reliable

6. **...Relevant:**

0 10 20 30 40 50 60 70 80 90 100

Not Relevant — Completely Relevant

...Policy Implementation decisions is...

7. **...Sufficient:**

0 10 20 30 40 50 60 70 80 90 100
Not Sufficient ... Completely Sufficient

8. **...Reliable:**

0 10 20 30 40 50 60 70 80 90 100
Not Reliable ... Completely Reliable

9. **...Relevant:**

0 10 20 30 40 50 60 70 80 90 100
Not Relevant ... Completely Relevant

...Staff and Faculty Administrative decisions is...

10. **...Sufficient:**

0 10 20 30 40 50 60 70 80 90 100
Not Sufficient ... Completely Sufficient

11. **...Reliable:**

0 10 20 30 40 50 60 70 80 90 100
Not Reliable ... Completely Reliable

12. **...Relevant:**

0 10 20 30 40 50 60 70 80 90 100
Not Relevant ... Completely Relevant

...Resource Allocation decisions is...

13. **...Sufficient:**

0 10 20 30 40 50 60 70 80 90 100

Not Sufficient — Completely Sufficient

14. **...Reliable:**

0 10 20 30 40 50 60 70 80 90 100

Not Reliable — Completely Reliable

15. **...Relevant:**

0 10 20 30 40 50 60 70 80 90 100

Not Relevant — Completely Relevant

As was the case with the decision structure instrument, these scales were added together, for each of the attributes, to get a total score and then averaged over the number of responses. This process provide an attribute score between 0 and 100 points for each of the three information attributes.

Decision Environment

Two dimensions of the individual user's decision environment were considered here: organizational level and type of decision being made. This conceptualization of a decision environment has been supported by Sackman (1972), Cheney and Dickson (1982) and Franz and Robey (1986).

In this research, the level of managerial activity was controlled. That is, all the subjects sampled were in the middle level (Gorry and Scott Morton's Control Level) of management. Membership in this level of management was determined by the criteria presented in Chapter 2. In this way, variance due to differences in organizational level was eliminated.

The type of decision being made was controlled in a method similar to one employed by Cheney and Dickson (1982). In their study, the subjects were asked to respond to the relevant items by classes of major decisions made. Cheney and Dickson employed a seven-point Likert scale to measure their variable. The subjects in this study were asked to respond in a similar manner; however a 100-point scale was used in lieu of the Likert scale. The 100-point scale, as mentioned before, allows for greater quantitative discrimination by the subject.

The following classes of decisions (derived from the literature review; see Chapter 2) were used in the third pilot of the survey:

- Policy
- Budget/Finance
- Staff/Personnel
- Resources
- Administration

However, results from the pilot survey indicated that the Administration category was too broad a classification and yielded very inconsistent results. Therefore, the Budget/Finance classification was divided into two. Subjects were asked to respond to items regarding Budget Monitoring and Forecasting Budgets in lieu of a single question on budgets and one on general administration. This change was arrived at by interviewing administrators at the sites and by examining the budget process, which involves both the preparation and execution of the budget.

These categories allow for the quantitative measurement of the dependent variables by types of decisions made. The percentage of decisions made in each category will differ according to the individual user. However, a full range of managerial decisions are reflected in the five categories. In this way the design attempts to capture the full decision environment of the individual user. It also prevents skewed results which could be obtained by very general responses from the users who would focus on their major area of responsibility. Such a focus could bias the results, depending on the congruence between the primary area of focus and information technology usage. By use of a broad range of decision categories, an attempt has been made to reduce or eliminate such bias.

Information Technology Environment

The information technology environment was defined earlier as the hardware, software and communication configuration of the user's computer technology working environment. One difficulty in measuring this variable is the absence of a previous operationalization in the literature. In earlier studies, the presence of a computer system has constituted an information technology environment, with no attempt made to discriminate between levels of that environment.

Therefore, an original instrument had to be developed to measure this variable. Based on a review of the current state of information technology, a series of questions was developed to identify configuration of the hardware, software and communications available to the user. This measurement was of both the user's personal computing system(s) and the institution's larger system(s).

The question may be raised as to why the information was not gathered directly from the institutions involved in the study. The answer is twofold. First, as the review in the previous chapter indicates, there is a high probability that the user's information configuration may differ from an organizational view of that configuration. The user may have augmented or enhanced the facilities available to him. Second, even though hardware, software or communication systems may exist in an institution, there is no assurance that the existence of such systems is known to the user and constitutes part of the user's information technology environment.

The items to be used were derived from the survey by Frand and McLean (1986) which sampled computing in academic institutions. Additionally, with respect to the items for the institution's larger system(s) configuration, computing officials were contacted at both sites to insure that all facilities listed were available at the sites. The items were scored by giving a point for each characteristic present in the user's environment. The 'yes/no' questions (1,3, & 4 below) received 1 point for a yes and 0 for a no. The configuration questions (2, 5, 6, & 7 below) had the potential to generate more than one response; the subject received 1 point for each item present in his environment. The questions were added together to obtain a total value for the user's information technology environment. The maximum number of points was 33.

Following the third pilot the coefficient alpha of this section was .4879. This preliminary finding represents a less than desirable level. Also, during this pilot, it was found that Question 1 was negatively and significantly correlated with the rest of the questions. Elimination of this question would have improved the alpha value. However, at this point it was conceptually unsatisfactory to eliminate the question prior to the final analysis because the pilot size was too small to justify such an elimination of a theoretically important item. The resulting instrument is displayed below.

> The following are questions about the information technology available to you, and how you use that technology. Please **circle the correct number** according to your individual situation.

1. Do you have a personal computer in your office or at your place of work? **[Terminals and home computers are covered below.]**

    1) Yes
    2) No (If no, then skip the next question.)

2. Which of the following options does your personal computer have? **[CIRCLE all that apply.]**

    1) Color/Graphics Display
    2) Hard Disk
    3) Modem
    4) Printer
    5) Mouse
    6) RAM greater than 512K

3. Do you have a terminal in your office or at your place of work?

    1) Yes
    2) No

4. Do you have a personal computer at your home?

    1) Yes
    2) No (If no, then skip the next question.)

5. Which of the following options does your personal computer have? **[CIRCLE all that apply.]**

    1) Color/Graphics Display
    2) Hard Disk
    3) Modem
    4) Printer
    5) Mouse
    6) RAM greater than 512K

6. Which of the following facilities are available to you at your institution?

    1) Plotter
    2) Mainframe Access
    3) Local Area Network
    4) National Network Access (CSNET, BITNET, ARPANET, etc.)
    5) Tape Backup
    6) Laser Printer
    7) Institutional Data Base System

7. Which of the following software packages are available to you on mainframe and/or micro systems?

    1) Text Editor
    2) Statistical Analysis
    3) Simulation Language
    4) Data Base System
    5) Graphics
    6) Spreadsheet
    7) Programming Language
    8) Text Formatter (Text Mark-up system)
    9) Communications
    10) Technical User Services
    11) Tutorial User Services

Individual User Perception and Judgment Types

Individual differences in perception and judgment, based on Jung's theory, have long been used in empirical research. His is the most enduring concept of cognitive style and has been extensively used in cognitive-related research (Blaylock & Rees, 1984; Zmud, 1979; Mason & Mitroff, 1971; Henderson & Nutt, 1980; and McGee, Shield & Birnberg, 1984).

Because it is a well-established construct, reliable measures of it have been developed for research and analysis. The Myers-Briggs Type Indicator (MBTI) has proven to be a valid and reliable measure of individual perception and judgment (Lake, Miles & Earle, 1973; and Zmud, 1978) and has been used in this research endeavor.

The complete form of the Myers-Briggs was not used. The type indicator in its full form is used for typing individuals and providing them with substantive feedback regarding their individual mental function types. Obtaining the necessary information for this feedback requires a lengthy, 162-item questionaire. Since this research did not attempt to provided the user with direct feedback, a shorter form of the Myers-Briggs was utilized. This 'short' form is common in non-feedback research. The questions selected for inclusion were selected in consultation with a Myers-Briggs Type Indicator Certified Tester.

The thirty-two questions are listed below:

Myers-Briggs Type Indicator (MBTI)

Read each of the following statements carefully and place a check by the answer which comes closest to telling how you **actually** feel or act.

1. Does following a schedule

    _____ appeal to you, or
    _____ cramp you?

2. Are you more careful about

    _____ people's feelings, or
    _____ their rights?

3. Are you inclined to

    _____ value sentiment more than logic, or
    _____ value logic more than sentiment?

4. Are you

    _____ easy to get to know, or
    _____ hard to get to know?

5. Are you usually

_____ a "good mixer", or
_____ rather quiet and reserved?

6. Do you get more annoyed at

_____ fancy theories, or
_____ people who don't like theories?

7. Do you prefer to

_____ arrange dates, parties, etc. well in advance, or
_____ be free to do whatever looks like fun when the time comes?

8. Can you

_____ talk easily to almost anyone for as long as you have to, or
_____ find a lot to say to certain people or under certain conditions?

9. When you are with a group of people, would you rather

_____ join in the talk of the group, or
_____ talk individually to people you know well?

10. When you start a big project that is due in a week, do you

_____ take the time to list the separate things to be done and the order of doing them, or
_____ plunge in?

11. When something starts to be the fashion, are you usually

_____ one of the first to try it, or
_____ not much interested?

12. Would you rather be considered

_____ a practical person, or
_____ an ingenious person?

13. In a large group, do you more often

_____ introduce others, or
_____ get introduced?

14. Would you rather have as a friend someone who

_____ is always coming up with new ideas, or
_____ has both feet on the ground?

15. When you go somewhere for the day, would you rather

_____ plan what you will do and when, or
_____ just go?

16. Would you rather

_____ support the established method of doing good, or
_____ analyze what is still wrong and attack unsolved problems?

17. Do you more often let

_____ your heart rule your head, or
_____ your head rule your heart?

> Look at EACH pair of words listed below and **circle the word in each pair** which appeals to you more.

WHICH WORD APPEALS TO YOU MORE?

18. systematic .... **OR** .... spontaneous

19. build .... **OR** .... invent

20. convincing .... **OR** .... touching

21. reserved .... **OR** .... talkative

22. statement .... **OR** .... concept

23. soft .... **OR** .... hard

24. forgive .... **OR** .... tolerate

25. hearty .... **OR** .... quiet

26. impulse .... **OR** .... decision

27. sensible .... **OR** .... fascinating

28. facts .... **OR** .... ideas

29. compassion .... **OR** .... foresight

30. orderly .... **OR** .... easy-going

31. systematic .... **OR** .... casual

32. thinking .... **OR** .... feeling

The questions were scored using an automated version of the Myers-Briggs scoring templates developed at Virginia Polytechnic Institute and State University. (The computerized scoring template has been used on other research projects.) The raw scores were converted to measure the type and strength of the Perception and Judgment mental functions. These were combined to form one of the four distinct cognitive types identified in the previous chapter.

User Sophistication

Two components of user sophistication were measured: first, the user's pattern of information technology usage and second, the user's level of familiarity with computer information technology. Alter (1980), Rockart and Flannery (1983), and Lucas (1982) suggested in their works that users could be differentiated in this manner.

As the review of the literature yielded no operationalization of these concepts, an original instrument was developed to discriminate between users levels of sophistication. The first section of questions uses Likert/summated scales to determine the frequency and type of information technology usage by the subject.

The second section attempts to measure the user's understanding/familiarity with information technology. Alter (1980), Duncan (1972), Cheney and Lyons (1980), and Keen and Scott Morton (1978) have identified technological skills as important differences in users and managers. As with usage patterns, a lack of historical precedent in the literature necessitated the development of an appropriate treatment.

The material content for this instrument was obtained by reviewing of the leading texts on information technology written for managers. The texts used are listed below:

- James A. Senn, Information Systems in Management
- Henry C. Lucas, Information Systems Concepts for Management
- Gary W. Dickson and James C. Wetherbe, The Management of Information Systems
- Robert C. Murdick, MIS Concepts and Design
- Gordon B. Davis and Margrethe H. Olson, MIS Concepts, Foundations, Structure and Development
- Peter G. W. Keen and Michael Scott Morton, Decision Support Systems: An Organizational Perspective

The resulting questions were organized into two sections. This first section consists of multiple choice questions, with the possibility of more than one correct answer. The second part contains Likert scale questions used to determine terminology familiarity. The intent behind this format was to determine the maximum level of discrimination between users with the least number of questions. The knowledge required to answer questions range from straightforward to relatively technical. In this way it was hoped that a wide range of variance could be measured.

These two components were refined over all three pilots. Each pilot resulted in a reduction of the questions' complexity to make them compatible with a level that could be reasonably expected of a manager. The coefficient alphas were:

Usage Pattern = .7309

Computer Literacy = .9641

There were three items in the instrument which were negatively correlated in a item-total correlation analysis. However, it was deemed inappropriate prior to collection of the data to eliminate the three questions. Therefore, they were retained pending the final analysis. The usage pattern items and computer literacy questions are presented below:

User Sophistication - Usage Pattern

The following are questions about the information technology available to you, and how you use that technology. Please **circle the correct number** according to your individual situation.

1. How often do you DIRECTLY use the personal computer in your office or place of work?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

2. How often do you use the computer in your office or place of work as a 'dumb' terminal connected to another computer system?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

3. How often per week do you DIRECTLY use the terminal at your office or place at work?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

4. How often do you DIRECTLY use the personal computer at your home?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

5. How often do you give directions to others to perform computer activities on your behalf?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

6. Of all the time available to your personnel, what percentage (out of 100%) is spend performing computer activities on your behalf?

____

7. How often do you perform numerical and/or spreadsheet analysis on a computer?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

8. How often do you use computer graphics (i.e., CAD, plots or spread graphs)?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

9. How often do you enter, manipulate and/or retrieve data from a computer data base?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

10. How often do you perform computer text editing?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

11. How often do you use a text formatter or mark-up language?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

12. How often do you use the technical assistance or user services department?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

13. How often do you seek computer assistance from a knowledgeable faculty or staff member you know?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

14. How often do you use electronic mail?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

15. How often do you program using a procedural (i.e., Fortran), simulation (i.e., LINDO) and/or symbolic (i.e., APL) language?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

16. How often do you develop your own utilities to facilitate your use of computer devices, such as Autoexecs, BAT files, Execs and the like?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

17. How often do you directly use off-the-shelf, packaged software?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

18. How often do you use software you directly developed by yourself (including modification to packages and use of templates)?

1	2	3	4	5	6
never	at least once a month	at least once a week	at least a few times a week	at least once a day	many times a day

The following questions are designed to determine your level of familiarity / knowledge in computer information technology. It is NOT expected that you will know all the answers. However, the instrument penalizes for 'guessing', so please refrain from making random guesses. Leave blank those questions for which you have no answer. The first set of questions may have more than one correct response. Circle the number of your selection or selections under each question.

1. Data Base Management Systems (DBMS) are used to store data. Which of the following terms are associated with data bases?

   1) Tuple
   2) Record
   3) Attribute
   4) File
   5) Relation
   6) Item or Atom

2. Data must be checked in order to insure that the desired computer operations will operate according to programming. What are some of the standard data checks?

   1) Sequence
   2) Format
   3) Batch Totals
   4) Reasonableness

3. Which of the following terms are used in association with a computer's memory or storage devices?

   1) Magnetic Tape
   2) Magnetic Disk
   3) Cache
   4) Bubble
   5) Compact Disk
   6) Floppy Disk Drive

4. Programming languages use control structures to direct the flow of processing. Which of the following is(are) language control structure(s).

   1) Statement Sequence
   2) Selection
   3) Repetition
   4) Infinite Loop

5. The Central Processing Unit (CPU) is a universal component of computers. Which of the following terms are associated with this component?

   1) Arithmetic & Logic Unit (ALU)
   2) Microinstruction Set
   3) Control Unit
   4) Main Memory (RAM)
   5) Accumulator
   6) Register

6. Which of the following terms are associated with computer communications?

    1) Asynchronous
    2) Duplex
    3) Serial Port
    4) Parallel Port
    5) Synchronous
    6) Front-end Processor

7. Which of the following integrated circuitry memory device types allow changes to the memory contents?

    1) ROM
    2) RAM
    3) PROM
    4) RPROM
    5) EPROM

8. Loss of precision in numbers can be introduced into information by a computer's operations. Which of the following conditions can result in a loss of precision?

    1) Truncation
    2) Underflow
    3) Rounding
    4) Overflow

9. Which of the following terms are associated with the uses of computer programming languages?

    1) Interpreter
    2) Assembler
    3) Linker
    4) Loader
    5) Compiler

10. When information is presented to a user of computer information systems, it assumes a format. Which of the following is(are) basic information portrayal formats?

    1) Text
    2) Graph
    3) Checklist
    4) Table

11. Binary coding of data is accomplished by the use of standard coding conventions such as:

    1) BCD
    2) EBCDIC
    3) ASCII
    4) SDBM

HOW FAMILIAR ARE YOU WITH THE FOLLOWING COMPUTER TECHNOLOGY TERMS?

Mark the appropriate box.

12. Mnemonics

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

13. Parser

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

14. Backup

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

15. Emulation

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

16. Pointer

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

17. Spooling

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

18. Networking

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

19. Virtual Memory

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

20. Multiplexor

not familiar	slightly familiar	somewhat familiar	moderately familiar	very familiar	extremely familiar

In the usage portion, subjects received points according to their frequency of usage as indicated on the Likert scale response. Points were assigned as follows:

never = 0

at least once a month = 1

at least once a week = 2

at least a few times a week = 3

at least once a day = 4

many times a day = 5

These usage values were added to form a usage index ranging from 0 to 90 points.

The computer literacy questions were scored by giving one point for a correct response. On the Likert familiarity scales, the user received one point for each level of familiarity above the 'Unfamiliar' box. The point breakdown was as follows:

not familiar = 0

slightly familiar = 1

somewhat familiar = 2

moderately familiar = 3

very familiar = 4

extremely familiar = 5

Various scoring methods for the literacy portion were tested, and this way proved to be the most reliable and internally consistent method of developing a numeric score. The two component scores were added to form a composite value for the level of user sophistication. The user sophistication score ranged from 0 to 185. [Usage = 90 points, and Literacy = 95 points (Knowledge Questions = 50 and Familiarity Scales = 45)].

The statistical methods which were employed to test the research hypotheses are outlined in the following section.

Data Analysis

The appropriate application of statistical methods is just as important as the accurate collection of data to be analyzed. The following section describes the statistical analysis which was employed to test the research hypotheses developed in the Chapter 2.

The four research hypotheses were processed through a three-phase analysis. The goal of the analysis was to test the null hypotheses. First, a correlation analysis was performed as the foundation for a factor analysis. Following the factor analysis, a second correlation analysis was performed on the refined instruments. Based on this correlation analysis, the reliability of the instruments was determined using the general form of the Spearman-Brown Prophecy Formula. After the final instrument scales were determined, the Pearson Product Moment Correlations were computed to examine the correlations between: (1) the items and the instrument total; (2) each dependent variable and the independent variables; and (3) each independent variable and the other independent variables.

Second, a simple regression analysis was performed on the dependent variables and the independent variable "user sophistication". This analysis indicated the operational characteristics of the dependent variables in response to an isolated measure of user sophistication.

Third, a multivariate regression analysis was performed using a research regression model developed from the Information Technology User Model. The research regression model is shown in Figure 4 on page 71.

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon$$

Where:

y_1 = Decision Structure

y_2 = Information Attribute - Relevance

y_3 = Information Attribute - Reliability

y_4 = Information Attribute - Sufficiency

α = the y intercept

β = slope corresponding to the i-th independent variable

x_1 = Decision Environment

x_2 = Information Technology Environment

x_3 = Individual User Perception and Judgment Type

x_4 = User Sophistication (Usage Pattern + Computer Literacy)

ε = Error

Figure 4. An Information Technology User Multiple Regression Model

Factor and Pearson Product Moment Correlation Analysis: The first phase of the analysis was to perform a factor analysis on each of the instruments developed for this research effort. The factor analysis was performed on each of the instruments to determine the dimensionality of each measurement. A varimax rotation was also employed as part of the analysis. The factor analysis indicates the number of discrete entities or factors which are being measured by a particular instrument. This process was used to investigate the instrument scales, corresponding to the research constructs. The instruments could possibly have contained items which did not perform as anticipated. Through this analysis, these items were identified and eliminated where appropriate. Although an instrument exhibits reliability, as measured by a coefficient alpha, it could theoretically be measuring two or more related factors. This analysis was performed to insure that in fact the instrument performed according to the intent of the researcher. Once the scale refinement was completed, the inter-item correlations were computed. Based on these correlations the coefficient alphas were computed. These could only be determined after the final instrument refinement had been performed. These coefficients provided an indication of an upper limit to the internal consistency of the instruments under analysis.

The purpose of the Pearson Product Moment Correlation analysis was to, after the scales were formed, examine the bivariate relationships between the dependent variables and the independent variable. The range of the sample correlation coefficient[14] runs from a + 1 to -1. The + 1 indicates that there is a strong positive linear association between the two variables. A -1 indicates that there is a strong negative (or inverse) linear association between the two variables, and 0 indicates that there is no relationship between the two variables. Values between 0 and + 1; and 0 and -1 indicates the degree of linear association. The strength of these correlation coefficients provides an indication of the contribution the independent variables will make to the regression analysis.

To review, the following are the variables which are under consideration in this analysis:

Type	**Variable**
Dependent	Decision Structure
Dependent	Information Attributes - Sufficiency
Dependent	Information Attributes - Reliability
Dependent	Information Attributes - Relevance
Controlled	Decision Environment

[14] The sample coefficient of linear correlation is also referred to as simply the correlation coefficient.

Controlled	Information Technology Environment
Controlled	Individual User Perception and Judgment Type
Independent	User Sophistication

The correlation analysis is also important in identifying multicollinearity which may exist between the independent variables in the research regression model. Multicollinearity is a condition whereby the independent variables are empirically (through the data measured) coordinated. In the extreme case, 'exact' collinearity, one independent variable can be explained as a linear combination of other independent variables, such that the covariance between them is 1. In any regression analysis caution must be exercised to identify this condition and adjust the analysis.

Linear Regression Analysis:: Initially, the four research hypotheses were tested using a simple linear regression model. Decision Structure and Information Attributes were the dependent variables of analysis, and User Sophistication was the sole independent variable. The regression model is specified in Figure 5 on page 74. The reason for this analysis is twofold. First, it provides a means for testing the significance of the relationships under analysis in an isolated setting. This adds additional insight into how the control variables affect the relationships established by this analysis. Second, it enables one to observe the way the dependent variables function in relation to the independent variable, User Sophistication.

Based on the review of the information systems literature there are some anticipated characteristics which were looked for in the behavior of the regression slope and the β_4. This type of prediction is possible in a linear regression model due to the limited dimensions. However, in a multiple regression analysis, due to the complexity of conceptualization in more than three hyperplanes, these predictions are difficult, if not impossible.

$$y = \alpha + \beta_4 x_4 + \varepsilon$$

Where:

y_1 = Decision Structure

y_2 = Information Attribute - Relevance

y_3 = Information Attribute - Reliability

y_4 = Information Attribute - Sufficiency

α = the y intercept

β_4 = slope corresponding to User Sophistication

x_4 = User Sophistication (Usage Pattern + Computer Literacy)

ε = Error

Figure 5. Simple Linear Regression Model

- β_4 of User Sophistication with Decision Structure (y_1): - Due to the complexity of the technology involved, it is anticipated that a user has to have a certain level of sophistication before he can use the full power of the technology to his benefit. Theoretically, this sophistication induces an awareness of the technology's benefits and more of the technology can be directly employed. Following this scenario it was anticipated that the β_4 would be a power function of x_4. The projected curve of such a function would be a very slight and gradual slope, which changes into a steeper and accelerated slope at some value of x_4. What this indicates is that there are stages in the user's sophistication. Theoretically, this could be the transition from the indirect user through the intermediate user to the direct user. At some higher level of sophistication the user is able to manipulate the information technology more directly, achieving more impact on his or her decision structure. This increased influence is represented by the steeper regression slope. This author anticipated that the exponent for x_4 in this regression analysis would range between 1.25 and 1.50.

- β_4 of User Sophistication with Information Attributes (y_2 y_3 y_4): - The slopes associated with the information attributes are less dynamic than that in the previous discussion. Appreciation of the benefits from information technology in terms of the information provided is more gradual. A constant slope with a value from .3 to .5 was envisioned. The rationale is that regardless of the type of information technology used or, more importantly, the usage pattern, the user has some concept of the characteristics or quality of the information provided by the technology. At higher levels of sophistication the user's perception of these attributes are consistent with the rate hypothesized.

To test the predictions under this model (Figure 5 on page 74) an overall 'F' test was used. The 'F' test is equal to the Mean Square (regression) ÷ Mean Square (residual), with (1, n-2) degrees of freedom. Following this test the research hypotheses were tested in the context of the Information Technology User Model.

Multivariate Regression Analysis: Following the completion of the previous analysis phase, each of the hypotheses was tested using the least squares solution to the general linear model, or, commonly put, multiple regression analysis.[15] The implemented model for the regression analysis is displayed in Figure 6 on page 76. There are some differences between this model and the one in Figure 4 on page 71. First, the independent variable x_1 has been eliminated. In the previous discussion of the control variables it was stated that the level of the managerial activity and category of decisions had been controlled. Due to this control the variance of this variable is 0, and since it is constant, it falls out of the equation.

Second, x_3 now equals x_{31}, x_{32}, x_{33} and x_{34}. In the discussion of the instruments it was mentioned that the user individual perception and judgment type was a categorical variable. As such, it was

[15] Regression analysis was selected over analysis of variance (ANOVA). The mean differences provided by ANOVA analysis would be sufficient to provide a statistically valid test of the null hypotheses. However, the use of regression can provide additional information which cannot be ascertained through ANOVA. Given a hypothesis, the study of the regression line corresponding to the level of User Sophistication can provide insight which can be used to discuss the interpretation and implications of the research results.

$$y = \alpha + \beta_2 x_2 + \beta_{31} x_{31} + \beta_{32} x_{32} + \beta_{33} x_{33} + \beta_{34} x_{34} + \beta_4 x_4 + \varepsilon$$

Where:

y_1 = Decision Structure

y_2 = Information Attribute - Relevance

y_3 = Information Attribute - Reliability

y_4 = Information Attribute - Sufficiency

α = the y intercept

β = slope corresponding to the i-th independent variable

x_2 = Information Technology Environment

x_{31} = Individual User Perception and Judgment Type NT

x_{32} = Individual User Perception and Judgment Type NF

x_{33} = Individual User Perception and Judgment Type ST

x_{34} = Individual User Perception and Judgment Type SF

x_4 = User Sophistication (Usage Pattern + Computer Literacy)

ε = Error

Figure 6. Implemented Multiple Regression Model

inappropriate to treat it as a continuous one. Therefore, dummy variables were established to represent each of the four mental function combinations. A value of 1 was assigned to the subject's particular type and 0's to all other. This is the prescribed method of treatment in Ott (1984).

The test on the research hypotheses was accomplished using a partial 'F' test (See Figure 7 on page 77). The reason for the use of this particular test was to evaluate the significance of the increased sum of squares of regression for User Sophistication when it was added to the model. Recall that the model has already accounted for the variance attributable to the Information Technology Environment and the User's Individual Perception and Judgment Type. Thus, the importance of User Sophistication can be determined in the context of the Information Technology User Model.

$$F = \frac{R\,(x_4 \mid x_2\, x_3)\ /\ 1}{S^2\,(x_2\, x_3\, x_4)} \qquad \text{df: } (1, n\text{-}6)$$

Where:

$R\,(x_4 \mid x_2\, x_3)$ = Sum of Squares (reg)

$S^2\,(x_2\, x_3\, x_4)$ = Mean Square Error

Figure 7. The Partial Regression 'F' Test

Note that in the regression model there are no factors for the non-additive interaction of the control and independent variables. This was due to the absence of such indications in the literature. In the absence of such support, it was not incorporated in the regression model, pending the outcome of the first phase correlation analysis.

The above discussion has outlined the methodological procedures and tests used to examine the hypotheses proposed in this research. The next chapter presents the quantitative findings which were produced by the analysis just outlined.

Chapter 4: Results

The purpose of the following chapter is to report the empirical findings of this research effort. The first section identifies the demographics of the subjects. The second section reports the results of the factor analysis and the modifications to the instruments. The third section presents the results of the Pearson Product Moment Correlation analysis. The fourth section reports on the significance of the linear regressions analysis, and the fifth section addresses the results of testing the hypotheses. The implications of these results will be discussed in Chapter 5.

User Demographics

This section summarizes the characteristics of the subjects who responded to the survey. The discussion will report the survey's response rate and the distribution of the subjects by academic discipline, managerial position and academic degree. These categories are identified for the overall subject population and by academic institution.

Survey Response: The surveys were mailed to the institutions for distribution on February 13, 1987. The first response was received on February 20, 1987, and the last was received on March 29, 1987.

Survey Action	Site 1	%	Site 2	%	Overall	%
Surveys Distributed	200	100%	200	100%	400	100%
Pre-Survey Anticipated Response Rates		60-70%		50-60%		55%-65%
Actual Survey Response	122	61%	107	53.5%	229	57.25%
Unusable Surveys	3	1.5%	6	3.0%	9	2.25%
Net Survey Response	119	59.5%	101	50.5%	220	55%

Figure 8. Survey Response: Site 1 = Mid-Atlantic academic institution; Site 2 = Northeastern academic institution

Of the 400 surveys which were distributed (200 at each site) 229 were returned for a 57.25% overall response rate. Twenty-four of those who responded were female (10.8%), and 199 were male (89.2%). Figure 8 on page 79 shows the response rates for each site.

Several observations can be made from the data in Figure 8. First, the survey response was in accordance with the anticipated estimates reported in Chapter 3. Second, the size of the sample is sufficiently large to negate questions of statistical significance due to insufficient sampling. (Without a sufficiently large sample size, failure to find any significant results could have been attributed to the small number of subjects, rather than the absence of a theoretical effect.) Last, the percentage of responses from the two sites[16] was roughly equal. This is important since a significant difference in response rate could have resulted in a bias.

Subjects' Academic Expertise: Figure 9 on page 80 displays the primary areas of academic expertise specified by the subjects. The numbers in parentheses following the academic disciplines are the referenced HEGIS codes used to classify the subjects' responses. HEGIS is the Higher Education

[16] **Throughout the remainder of this dissertation the Mid-Atlantic academic institution will be referred to as "Site 1." The Northeastern academic institution will be referred to as "Site 2."**

Academic Discipline	Site 1	%	Site 2	%	Overall	%
Agriculture (01)	9	7.6	0	0.0	9	4.1
Architecture (02)	5	4.2	0	0.0	5	2.3
Physical Sciences (04, 19)	4	3.4	3	2.9	7	3.2
Business (05)	17	14.4	22	21.0	39	18.1
Computer/Info Science (06, 07)	5	4.2	7	6.7	12	5.6
Education (08)	12	10.2	2	1.9	14	6.5
Engineering (09)	11	9.3	22	21.0	33	15.3
Artistic (10)	3	2.5	0	0.0	3	1.4
Veterinary (12)	6	5.1	0	0.0	6	2.8
Home Economics/Mgt (13)	4	3.4	0	0.0	4	1.8
Humanities (15, 49)	6	5.1	7	6.7	13	6.0
Mathematics (17)	4	3.4	3	2.9	7	3.2
Social Science (20, 21, 22)	10	8.4	26	24.8	36	16.7
Other (00)	17	14.4	10	9.5	27	12.5

Figure 9. Subjects' Academic Disciplines by Site: Site 1 = Mid-Atlantic academic institution; Site 2 = Northeastern academic institution

General Information Survey classification scheme. The figures represent the academic expertise of the site's administrators and are not totally representative of the academic disciplines taught at the institutions.

Both research sites are nationally know institutions with outstanding reputations, especially as engineering institutions. Over 15% of those who responded acknowledged an engineering background. This figure would have been larger except that the HEGIS code places operations research in the Business (05) classification. Among those who responded, 50.1% had backgrounds in engineering, business and social science areas. 'Social sciences' include psychology, history, geography, political science and sociology. Site 2 does not have any Agriculture, Architectural Design or Veterinary departments.

Locations = Position Title	Site 1	%	Site 2	%	Overall	%
Academic Dean or equivalent	5	4.2	3	3.0	8	3.6
Associate, Assistant Dean or equivalent	25	21.0	21	21.0	46	20.9
Department Head or equivalent	50	42.0	33	33.0	83	37.7
Director of a Center or equivalent	17	14.3	34	34.0	51	23.2
ROTC Officer	2	1.7	2	2.0	4	1.8
Other	20	16.8	8	8.0	28	12.8

Figure 10. Subject's Position by Site: Site 1 = Mid-Atlantic academic institution; Site 2 = North-eastern academic institution

The (00) code was used for those who did not fill out this portion of the survey. Some respondents from Site 1 declined to answer because of the possibility of identifying individuals by their position and academic expertise.

Subjects' Position Distribution: The subjects' position distribution is displayed in Figure 10. Since site 2 uses different titles which are equivalent to traditional academic 'Dean' and 'Department Head', these position titles use the "or equivalent" phrase. The title 'Director' refers to directors of academic centers (i.e., Research Stations, Curriculum, Instruction and Continuing Education) and administrative centers (i.e., Computer Center, Administration and Records, and Financial Aid). The 'Other' applies to positions with special administrative titles, such as 'Chief, 'Registrar,' 'Counsel,' or 'Chairman.' The distribution of the subjects is representative of the population targeted. The major middle management position titles (Deans through Department Heads and their equivalents,) account for 62.2% of the overall sample. The other types of middle managerial positions account for 37.8% of the sample.

Subjects' Degree Distribution: Figure 11 on page 82 shows the distribution of academic degrees, from high school diploma to doctoral degree. The disparity between master's and doctoral degrees

Locations = Academic Degree	Site 1	%	Site 2	%	Overall	%
High School Diploma	3	2.5	1	1.0	4	1.8
Bachelor's Degree	13	10.9	4	4.0	17	7.7
Master's Degree	22	18.5	70	69.7	92	41.8
Doctoral Degree	81	68.1	26	25.0	107	48.6

Figure 11. Subjects' Academic Degrees by Site: Site 1 = Mid-Atlantic academic institution; Site 2 = Northeastern academic institution

between sites is probability due to a higher emphasis on graduate studies at Site 1, although graduate students are present at both sites.

These summaries have characterized only those individuals who responded to the survey. The next sections in this chapter will show the empirical results of the statistical procedures which were outlined in Chapter 3.

Factor Analysis

The factor analysis was performed first. The purpose of this analysis was to determine the commonality of measurement within the instruments, i.e., the extent to which the multitude of items can be reduced to a single scale. This analysis identifies the discrete factors which are embedded within an instrument. In this way the scales to be used in the correlation and regression analysis can be identified. Ideally, there is only one factor per instrument. The initial analysis method employed was a Principal Component Factor Analysis, followed by a Varimax Rotation where appropriate. The advantage of principal component analysis is that it immediately expresses the results in terms of the factored scales. Other methods, such as 'principal factor,' do not offer this advantage, and must arrive at variable identification indirectly.

The criteria used to evaluate the factor analysis have been listed below. These evaluation criteria are listed in rank order.

1. **Eigenvalue:** The first criterion is the strength of the eigenvalue. The eigenvalue is analogous to the strength of the factor's commonality. Technically, it is the root corresponding to the simultaneous equations formed by the instrument.[17] Normally the minimum acceptable eigenvalue is 1 (Harman, 1976). However, due to the strength of the pilot results, a minimum value was set at 2.0.

2. **Thurstone's Simple Structure Theory:** Thurstone's Theory (Thurstone, 1947) is a semi-analytical method of determining factor structure. It advocates the use of objective procedures, such as Principal Component Analysis, which are coupled with an intellectual understanding of the rational intent of the analysis. Simply stated, the results of a factor analysis represent a numerical solution. The researcher must then apply logic to insure that the identified factors represent rational aspects of the theoretical construct. Thus, if the initial factor method fails to clearly identify the factor(s), the best way to view them is to perform a rotation. The rotation, using the graphical method, represents an iterative movement of the Factor and Item axes to identify an orthogonal factor solution. An orthogonal Varimax Rotation was employed in this study.

3. **Factor Ratio:** The last criterion used was a practitioner's technique developed at Virginia Polytechnic Institute and State University's Office of Institutional Research. In Thurstone's theory the distribution of the explained variance, as computed from the inter-item correlation matrix, is important in identifying logical components. In this technique, the ratio of the first two principal components' eigenvalues is used to evaluate the obliqueness of the explained

[17] Principal component factor analysis is accomplished through the use of matrix algebra. The rows correspond to the items within the instrument, and the columns correspond to the factors (one per item in a full rank matrix). Through the use of the item's inter-item correlations, the simultaneous equations are solved to maximize the variance extracted by each of the factors. The resulting 'loading factor' values represent the strength of the association or commonality of a particular item to each of the factors.

variance distribution. The rule of thumb is, when the ratio exceeds 2:1 on the principal component analysis between the first eigen value and second factor, the single factor solution is appropriate. Practical experience has shown that when this ratio is exceeded, the distribution is very oblique, with a significant proportion of the variance being explained by the first factor. Further segmentation often results in the creation of ambiguous factors. This is because when the first factor exhibits a relatively strong eigen value, there tends to be item coupling with other factors which have only one or two distinctly loaded items. This coupling reduces the ability to find meaningful factors in terms of Thurstone's Simple Structure.

The results of the factor analysis are displayed in Figure 12 on page 85. Three aspects of the figure need explanation. First, the information technology environment construct (labeled Technology Environment) following the principle component analysis had to be rotated to identify the major factors. The four variables listed are the ones identified after the varimax rotation. The percentage of variance explained is in relation to this four-factor solution. Second, the dimensions of user sophistication were clearly two separate variables following the initial analysis, and they were treated accordingly. Third, the individual user judgment construct failed to pass the ratio test, yet is still listed as a single variable solution. There are three reasons for this exception. They all lie in the method in which the MBTI is scored. First, the judgment mental function has unequal items. The T type has 8, and the F type has 5. Second, four of the items are sex specific, that is, the score is determined by the question response and the respondent's sex. Third, only 10% of the subject population were females, which complicated the first and second reasons. This rationale for the 'weak' factor performance was checked by doing a factor analysis with sex included and verified with a data base which contained a higher percentage of women. This investigation indicated that the factoring process was influenced by the aspects cited above. Therefore, the judgment mental function was left as a single variable as noted in Figure 12 on page 85.

Construct	EIGEN VALUE	% Var. Explained	Factor Ratio	No. of Items	Alpha
Decision Structure	3.112	75.25	3:1	5	.8454
Information Attribute					
Sufficiency	3.529	70.60	-	5	.8950
Reliability	3.659	73.83	-	5	.8932
Relevance	3.508	70.17	-	5	.9109
Technology Environment					
Software	6.393	39.23	1.6:1	12	.9122
Home Microcomputer	3.947	24.22	1.2:1	6	.8466
Office Microcomputer	3.099	19.01	1.1:1	8	.7524
Hardware/Communications	2.856	17.52	1.1:1	6	.7524
Individual User Perception	3.466	76.73	3.3:1	8	.7986
Individual User Judgment	2.504	61.57	1.6:1	8	.6611
User Sophistication: Usage Pattern	5.670	64.01	3.7:1	13	.8877
User Sophistication: Computer Literacy	10.834	78.71	7.6:1	20	.9478

Figure 12. Factor Analysis Summary: '% Var Explained' = percentage of variance explained by the factor; 'Factor Ratio' = ratio of the factor's explained variance to the next identified factor's explained variance; 'Alpha' = Reliability Coefficient Alpha **NOTE: The factor loading tables are located in the appendix to this study.**

Of the 102 questions in the survey, five questions were dropped. The questions which were dropped were: User Sophistication: Usage Pattern Question 13, and MBTI Questions 11, 14, 21 and 26. The Technology Environment variables were scaled as follows:

- Software - Question 7 with all response items
- Home Microcomputer - Questions 4 & 5 with all response items
- Office Microcomputer - Questions 1 & 2 with the 'Mouse' item deleted
- Hardware/Communications - Question 6 with the 'Plotter' item deleted

The Technology Environment Question 3 was eliminated because it loaded ambiguously. The remainder of the constructs (Decision Structure, Information Attributes, Individual User Perception and User Sophistication: Literacy) were scaled as they appeared in Chapter 3.

Reliability Coefficient Alpha: Chapter 3 discussed the importance of the reliability coefficient alpha corresponding to each of the instruments (Footnote 13). Following the completion of the scaling of the variables within the instruments, the alpha's were computed. (They were also listed in Figure 12 on page 85.) Following each scale is the appropriate coefficient alpha from the study. This is followed by the alpha computed from the third pilot.

- Decision Structure α = .8456 / .8436
- Information Attribute - Sufficiency α = .8950 / .9487
- Information Attribute - Sufficiency α = .8932 / .9706
- Information Attribute - Sufficiency α = .9109 / .9660
- Information Technology Environment - Software α = .9122 / .4879[18]
- Information Technology Environment - Hardware α = .8466
- Information Technology Environment - Office Microcomputer α = .7524
- Information Technology Environment - Home Microcomputer α = .7524
- Individual User Perception Type α = .7986
- Individual User Judgment Type α = .6611
- User Sophistication - Usage Pattern α = .8877 / .7309
- User Sophistication - Literacy α = .9478 / .9641

As a rule of thumb, reliability coefficient values above .60 are acceptable and values above .70 are preferred (Nunnally, 1978). Only one of the alpha's is not above this preferred range. On closer examination the problems which were raised in the factor analysis regarding the individual user

[18] Only one pilot value appears for the information technology scales. The reason is the initial indication from the pilot was that this was a single variable construct. The actual study indicated differently; thus the single value for the four scales.

judgment type also apply here. The problems of gender and scoring which influence the correlation computations for the factor analysis also retard the value of the alpha. However, even at .66 this measure still qualifies as a reliable one. Also worth note is the significant improvement in the reliability of the technology environment scales. During the last pilot the reliability of this measure was only .4879, but after the factor analysis's the scale's alpha coefficients range from .7524 to .9122. In summary, the variables which were developed have demonstrated acceptable levels of internal reliability.

Following the completion of the scaling and reliability testing, the Correlation Analysis was performed. The results of that analysis are the next section.

Correlation Analysis

This section reports the results of the second phase Pearson Product Moment Correlation Analysis. As stated in Chapter 3, the purpose of this was to test for multicollinearity in the control and independent variables, and to make a preliminary test for relationships between these same variables and the dependent variables. The multicollinearity facet will be discussed first.

Multicollinearity: There are three primary methods of examining for multicollinearity: Correlation Matrix examination, Variance Inflation Factors (VIF), and Eigensystem Analysis (Montgomery & Peck, 1982). All three methods were used in this analysis. In Figure 13 on page 88, the results of the correlation coefficient computations are displayed in matrix form. The figure shows there are no traditional indications (Ott, 1984; and Montgomery & Peck, 1982) of such a statistical condition. Normally, when multicollinearity exists, the correlations either have several coefficients in the .90 or above range, or have many coefficients in the .70 to .80 range. The largest correlations are in the .5 to .6 range. Another possible indication is several coefficients with the 'wrong sign.'

	TE SW	TE HW	TE MC	TE HMC	TYPE ST	TYPE SF	TYPE NT	TYPE NF	USUP	USL
Construct Variables										
TESW										
TEHW	.56**									
TEMC	.38**	.17*								
TEHMC	.34**	.24**	.38**							
TYPE (ST)	.05	.03	-.14*	-.14*						
TYPE (SF)	-.03	-.05	.12	-.01	-.37**					
TYPE (NT)	-.05	.00	.07	.15*	-.68**	-.19**				
TYPE (NF)	.04	-.00	.00	.01	-.33**	-.09	-.17*			
USUP	.45**	.43**	.50**	.55**	-.08**	-.01	.09	.01		
USL	.53**	.39**	.38**	.44**	-.06**	.00	.07	-.01	.66**	

Figure 13. Pearson Product Moment Correlation Summary:

'TE' = Technology Environments: SW -Software, HW Hardware, MC -Office Microcomputer & HMC -Home Microcomputer;
'TYPE' = Individual User Perception and Judgment Types
'USUP' = User Sophistication Usage Pattern;
'USL' = User Sophistication Literacy.

** = ρ < .01 & * = ρ < .05

In this respect, the grouping of the technology environment factors, psychological type factors, and user sophistication factors is consistent with anticipated results. However, the low values do not on their own remove the question of multicollinearity. This is especially true when there is more than one regressor, and low correlation coefficients which are statistically significant. Thus, there is a need to use the other methods to test for this condition.

The next method computes and examines the variance inflation factors (VIF). This method measures the combined effect of the dependencies among the model variables on the variance of a regressor. If multicollinearity is present, one or more of the factors will be large. 'Large' is a relative term. However, practical experience has shown that variance inflation factors which exceed 10 are an indication of multicollinearity, and the regression coefficient will be overestimated (Montgomery

& Peck, 1982: 300). The variance inflation factors for the variables identified in the factor analysis were computed, with the following results.

- Information Technology Environment: Software VIF = 1.905
- Information Technology Environment: Hardware VIF = 1.587
- Information Technology Environment: Office Microcomputer VIF = 1.506
- Information Technology Environment: Home Microcomputer VIF = 1.524
- Individual User Perception and Judgment Type: 'ST' VIF = 3.727
- Individual User Perception and Judgment Type: 'SF' VIF = 2.032
- Individual User Perception and Judgment Type: 'NT' VIF = 3.386
- User Sophistication - Usage Pattern VIF = 2.447
- User Sophistication - Computer Literacy VIF = 2.038

Clearly, none of the variance inflation factors indicate the presence of a multicollinearity condition according to the criteria given by Montgomery and Peck (1982).

A last method of checking for multicollinearity is the eigensystem analysis condition number (κ) (Montgomery & Peck, 1982: 301).[19] In this method the eigenvalues from the ρ x ρ matrix are computed. The matrix is used to compute the eigenvalues for the regressor. The values are then used to compute a multicollinearity estimate for the entire regression model. This value is called the 'Condition Number.' The 'Condition Number' is determined by dividing the largest eigenvalue by the smallest eigenvalue corresponding to the regressors. Values of 100 to 1000 indicate moderate multicollinearity, and over 1000 indicates a severe condition. This computation was performed for the Information Technology User Model and κ = 33.2911. This value is well within the range where Multicollinearity "...is no serious problem..." (Montgomery & Peck, 1982: 301-302). There-

[19] It should be noted that only in conditions of perfect orthogonality is there a total absence of multicollinearity. This statement implies that this condition is sufficiently small not to interfere with an accurate interpretation of the regression results.

fore, in the absence of any supporting evidence, this study will assume multicollinearity conditions do not exist within the control and independent variables.

Correlation Analysis Results: The last part of the correlation analysis was to initially examine the relationships between the control and independent variables and each of the dependent variables. This information is displayed in Figure 14. There is one important fact worth noting: the correlation coefficients are pairwise and only give an indication of the pairwise association between the two variables. This association can change when a multivariate regression analysis model is used.

In Figure 14, the control and independent variables have been separated according to the results of the factor analysis. Those coefficients which are statistically significant[20] have been noted. Four observations are warranted.

- First, the user's computer literacy appears to be important in relation to all four dependent variables. It is the only statistically significant scale across the board in this pairwise comparison.

- Second, the user's usage pattern only appears to be important in relation to the user's perceived decision structure. Its performance in relation to the information attributes is marginal.

- Third, the information technology environment's software and hardware factors are the only significant dimensions. Their importance within the technology environment is in relation to the information attributes and is not demonstrated in relation to decision structure.

- Fourth, concerning the user's perception type, the 'N' (intuitive) mental function appears to be inversely related to sufficiency and relevance.

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[20] Statistically significant indicates that there is a very low probability of accepting a hypothesis as true when in fact it is false. In this specific case, the hypothesis would be that a relationship exist between the two specified variables. The strength and magnitude of the relationship is represented by a number between -1.0 and +1.0. Note that the statistical significance does NOT change the strength of the association represented by the coefficient of correlation.

Dependent Variables	Decision Structure	Information Attribute Sufficiency	Reliability	Relevance
Control & Independent Variables				
Technology Environments				
Software	.1318	.2353**	.2588**	.2507**
Office Microcomputer	.0576	.0788	.0499	.0475
Home Microcomputer	-.0342	.0509	.0278	.0384
Hardware/Communications	.1234	.1628*	.1963**	.1476*
Individual User Perception and Judgment Types				
Type ST	.0762	.1199	.0885	.0865
Type SF	.0828	.0622	.0246	.0343
Type NT	-.0653	-.0483	-.0545	.0204
Type NF	-.1211	-.2123**	-.1020	-.2349**
User Sophistication: Usage Pattern	.1888**	.0960	.0838	.0971
User Sophistication: Computer Literacy	.1559*	.2137**	.2630**	.1626**

Figure 14. Pearson Product Moment Correlation Analysis: ** = $\rho < .01$ & * = $\rho < .05$

These coefficients are only a pairwise comparison and can thus only provide an indication of how the specific variables may perform in the regression analysis. Based on this comparison, one would look for user's computer literacy, technology environment - software and technology environment - hardware to be primary candidates in a multivariate regression analysis. The results of the linear regression analysis are presented next.

Linear Regression Analysis

To provide an understanding of the relationships between user sophistication and the dependent variables, a Linear Regression Analysis was proposed in Chapter 3. The purpose of the analysis

Independent Variable: User Sophistication: Usage Pattern

Source	Df	Sum of Squares	Mean Square	F =
Model	1	4020.897	4020.897	8.28
Error	216	104951.264	485.885	
Corrected Total	217	108972.161		
	R^2 = .02430			PR > F =.0044

Independent Variable: User Sophistication: Computer Literacy

Source	Df	Sum of Squares	Mean Square	F =
Model	1	2648.426	2648.426	5.38
Error	216	106323.734	492.239	
Corrected Total	217	108972.161		
	R^2 = .03689			PR > F =.0213

Figure 15. Linear Regression Analysis of Decision Structure: The literacy model used a straight linear regression analysis. The usage model used an exponential transformation.

is to look at the relationships before the other regressors are placed in the Information Technology User Model. It also provides a look at the way these relationships are modified when they are examined in the full model.

However, as a consequence of the factor analysis, the proposed procedure was modified. The modification to the regression analysis was that User Sophistication was tested in two ways. Since the factor analysis indicated that the User Sophistication construct was composed of two scales (one per dimension), the regression analysis was performed twice. One analysis looked at the linear relationship between the user's usage pattern and the dependent variables. The second examined the user's computer literacy under the same conditions. The regression results are displayed in Figure 15, Figure 16, Figure 17, and Figure 18. Each figure lists the results of both analyses for the particular dependent variable.

The results listed in Figures 15 - 18 are consistent with those relationships identified in the correlation analysis. Literacy is a significant regressor for all four dependent variables. With the exception of information relevance, all tests are significant at the .01 level. This means that the user's computer literacy, as an independent variable, can explain some of the variance in the dependent vari-

Independent Variable: User Sophistication: Usage Pattern

Source	Df	Sum of Squares	Mean Square	F =
Model	1	955.166	955.166	1.99
Error	214	102619.642	479.5310	
Corrected Total	215	103574.808		
	R^2 = .0092			PR > F =.1596

Independent Variable: User Sophistication: Computer Literacy

Source	Df	Sum of Squares	Mean Square	F =
Model	1	4734.081	4734.081	10.25
Error	214	98840.727	461.872	
Corrected Total	215	103574.808		
	R^2 = .0457			PR > F =.0016

Figure 16. Linear Regression Analysis of Information Sufficiency: Both models employed a straight linear regression analysis, without data transformation.

ables. On the other hand, the user's usage pattern is only significant in explaining the variance in Decision Structure.

In Chapter 3 it was hypothesized that the β_4 in the decision structure equation would be an exponential transformation of the data with a power ranging from 1.25 and 1.50. The initial scatter plots indicated that there was a possibility of such a relationship. Based on the plots, both literacy and usage were tested with increasing exponents between 1.05 and 1.65. The best regression solution for

Independent Variable: User Sophistication: Usage Pattern

Source	Df	Sum of Squares	Mean Square	F =
Model	1	768.955	768.955	1.52
Error	214	108585.076	507.406	
Corrected Total	215	109354.032		
	R^2 = .0070			PR > F =.2197

Independent Variable: User Sophistication: Computer Literacy

Source	Df	Sum of Squares	Mean Square	F =
Model	1	7567.007	7567.007	15.91
Error	214	101787.025	475.640	
Corrected Total	215	109354.032		
	R^2 = .0691			PR > F =.0001

Figure 17. Linear Regression Analysis of Information Reliability: Both models employed a straight linear regression analysis, without data transformation.

Independent Variable: User Sophistication: Usage Pattern

Source	Df	Sum of Squares	Mean Square	F =
Model	1	1000.734	1000.734	2.04
Error	214	105041.674	490.848	
Corrected Total	215	106042.409		
	R^2 = .0092			PR > F =.1548

Independent Variable: User Sophistication: Computer Literacy

Source	Df	Sum of Squares	Mean Square	F =
Model	1	2804.693	2804.693	5.81
Error	214	103237.716	482.419	
Corrected Total	215	106042.402		
	R^2 = .0264			PR > F =.0167

Figure 18. Linear Regression Analysis of Information Relevance: Both models employed a straight linear regression analysis, without data transformation.

usage was an exponent of 1.44. However, this transformation only represented a .001 R^2 improvement in the model. Thus, the best solution for literacy was found to be a non-transformed linear regression model.

Since the user's computer literacy was the only variable found to be significant, the following discussion of the information attributes model has been limited to that variable. In Chapter 3, the slope of the regression line was envisioned to be between .3 and .5. In the linear regression models, Computer Literacy's slopes were as follows:

- Information Sufficiency - Slope = .20; Significance = .0664
- Information Reliability - Slope = .26; Significance = .0001
- Information Relevance - Slope = .15; Significance = .0167

The slope between information relevance and literacy approaches the anticipated results, and the slope estimate for sufficiency is marginal. In general, the slopes are shallow and the regression line indicates changes in the degree of information perception required and even greater changes in the level of the user's computer literacy as measured by these scales. Such a change is on the order of 3 to 1. In the absence of any other regressor variables, the user's computer literacy does explain some of the observed variance. The question is, will the scale continue to be significant when entered into the information technology user model? This question is addressed in the following chapter.

The implications of this and the multivariate regression analysis will be discussed in the next chapter. Before that discussion however, the results of the multivariate regression analysis are presented next.

Hypothesis Testing

This section of the dissertation presents the results of the tests using a multivariate regression analysis performed on the four hypotheses. In Chapter 2, the model of the information technology users was constructed. This model served as the basis for the regression model. However, after the factor analysis some modifications were necessary to reflect the results of that analysis.

Model and Regression Modifications

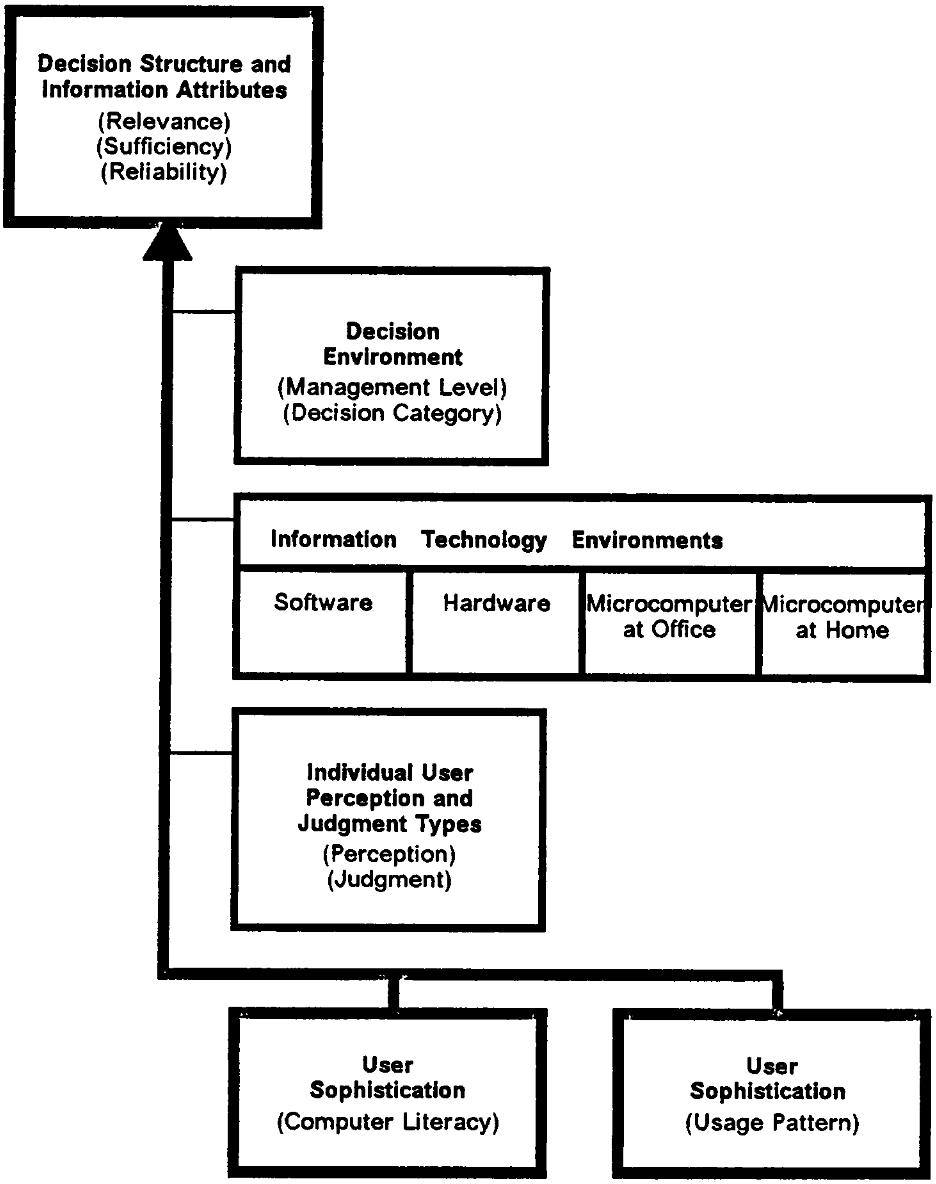
Figure 19 on page 96 reflects the changes to the user model. First, the information technology environment is represented by four environmental scales instead of one. These correspond to the factors identified earlier in this chapter: software, hardware, office microcomputer and home microcomputer. The second change is that user sophistication is now represented by two scales. As stated earlier, the dimensions identified in Chapter 2, following the factor analysis, were treated as two different factors of the user sophistication construct. The impact of these changes on the regression analysis is discussed next.

There are three modifications to the regression analysis. First, the information technology environment construct is now represented by four control regressors in the regression model. This will

Figure 19. A REVISED Model of the Information Technology User

Decision Structure & Information Attributes - a function of

1. Decision Environment
2. Information Technology Environment(s)
3. Individual User Perception and Judgment Types
4. User Sophistication - Usage Pattern
5. User Sophistication - Computer Literacy



not directly affect the hypothesis testing, because the regression model is not being used for predictive purposes. The intent of the hypotheses is to identify an association between user sophistication and the dependent variables, in the presence of the control variables. Thus, in this modification the information technology environment is represented by four control variables instead of one, as explained above. This will make it more difficult to accept the research hypotheses, due to the increased number of variables in the equation.

The second modification is that only three of the perception and judgment types are in the analysis equation. This is due to an anomaly of categorical variables. When categorical (or dummy) variables are used, if all the categorical regressors are placed in the regression equation they form a perfect linear combination. This type of combination renders interpretation meaningless. The accepted approach to this situation is to remove one of the variables (Neter, Wasserman & Whitmore, 1978; and Montgomery & Peck, 1982). Thus, the 'NF' is not represented in the multivariate regression equation. The 'NF' was removed since in a comparative multivariate regression analysis its performance was not as good as the other three types. Additionally, combinations of 'types' with the 'NF' type in the regression were checked and the results and significance levels of the hypothesis tests were not altered.

The third change is that user sophistication is represented by two variables. In the actual test of the hypotheses, the association of both variables was checked. This check was in the presence of the other user sophistication dimension. As an example, when testing for a relationship between the user's usage pattern and decision structure, in addition to eliminating the variance due to the control variables, variance due to computer literacy was also eliminated. This method of testing is conceptually and statistically consistent with the procedures outlined in Chapter 3.

The last aspect is not really a change, but a lack of one. Earlier the subject of interaction was mentioned in the methodology discussion. A possible interactive term existed between the user's computer literacy and the user's usage pattern. The effects of introducing this term were tested. The results were a 3.4% degradation of the model's R^2 and the introduction of a large amount of multicollinearity. In addition, the term was not statistically significant. Therefore, the revised model and regression analysis do not utilize any multiplicative interactive regressors. In Chapter 2 a discussion was proposed based on the possible existence of the relationships just mentioned;, since they did not materialize the discussion has not been included in this analysis.[21]

Test Results

The results of the multivariate regression analysis[22] described in Chapter 3 are presented in this section. There are four figures, each corresponding to a dependent variable. Each figure contains four blocks of information:[23]

1. Test for Significance of Regression: This test determines if there is a linear relationship between the dependent variables and any of the regressor variables. The null hypothesis is:

   $$H_0: \ \beta_2 = \beta_3 = \beta_4 = 0$$

   If at least one of the regressors contributes significantly to the model, the null hypothesis is rejected. This indicates that a portion of the model explains the variance of the dependent variable.

2. TYPE I SS: The Type I Sum of Squares tests are the sequential F-test of the regressors. In a multivariate regression analysis, the sequence in which the variables are introduced into the model can influence the significance of the regressors. As the regressor is introduced into the

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[21] For completeness, the other variable combinations with significant pairwise correlations above .40 were checked, with the same relative results.

[22] There are several underlying assumptions regarding the use of a multivariate regression analysis. The key to these assumptions is that the technique assumes a normal distribution for the variables. The check for normality used the Kendall and Stuart (1958) criterion based on kurtosis and skewness of the regressor's distribution. All the regressors passed this criterion, except decision structure. Decision structure had a 15% probability of coming from a distribution other than normal. However, the 'F' test is very tolerant with respect to the normality requirement. Due to the robustness of this test (Neter, Wasserman & Whitmore, 1979), this scale was accepted without adjustment.

[23] The discussion and significance of the model's R^2 has been deferred to Chapter 5.

regression model, the Type I SS tests the significance of that regressor. This test is in the presence of the variables which have already been placed into the model. This test determines if the $\beta = 0$ while the variance due to regressors already in the model has been controlled for.

3. TYPE III SS: This is the partial F-test for the regression model. This test is identical to the last sequential F-test. It determines the contribution of the regressor after all other regressors have been entered into the model. It represents and measures the contribution of the regressor as the last variable added to the model. This test is less robust since the regressor has to be strong to be significant in the presence of the other model regressors. It is this test which has been used to test the research hypotheses.

4. Parameter Estimates: The last portion of each table shows the estimate of the β's (slopes) for each of the regressors. This tests the β corresponding to each of the parameters. The null hypothesis is that the $\beta = 0$.

The testing of the research hypotheses was performed in the manner previously outlined. The hypotheses were accepted if one or both of the user sophistication dimensions contributed significantly to the regression model. This significance was tested using the partial F-test. The sequence of variable introduction was in accordance with the Information Technology User Model. The results of the hypothesis tests are discussed below.

Decision Structure Tests: The tests on decision structure have been displayed in Figure 20 on page 100. The test for significance of regression shows that at least one of the regressors makes a significant contribution ($PR < .0105$). Sequentially, software technology environment and user's usage pattern make a significant contribution in the sequence in which they were introduced into the model. Individual user perception and judgment as expressed by 'SF' type is a borderline regressor.[24]

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[24] A borderline regressor is one whose probability ranges between .05 and .10. It indicates that through future modification the regressor may become significant. It lies in the "grey" area (Ott, 1982).

Dependent Variable: Decision Structure

Source	Df	Sum of Squares	Mean Square	F =
Model	9	10553.088	1172.565	2.48
Error	208	98419.073	473.168	
Corrected Total	217	108972.161		
R^2 = .0978		C(P) = 10.0		PR > F = 0.0105

Source	Df	TYPE I SS	F Value =	PR > F
TESW	1	1893.251	4.00	.0468
TEHW	1	389.577	0.82	.3653
TEMIRCO	1	14.398	0.03	.8617
TEHMIRCO	1	983.197	2.08	.1509
TYPE ST	1	403.130	0.85	.3571
TYPE SF	1	1467.931	3.10	.0796
TYPE NT	1	780.296	1.65	.2005
USAGE PATTERN	1	4479.031	9.47	.0024
COMPUTER LITERACY	1	142.291	0.30	.5840

Source	Df	TYPE III SS	F Value =	PR > F
TESW	1	297.039	0.63	.4291
TEHW	1	5.336	0.01	.9155
TEMIRCO	1	148.116	0.31	.5764
TEHMIRCO	1	2781.161	5.88	.0162
TYPE ST	1	1731.296	3.66	.0571
TYPE SF	1	2335.030	4.93	.0274
TYPE NT	1	723.915	1.53	.2175
USAGE PATTERN	1	2935.829	6.20	.0135
COMPUTER LITERACY	1	142.291	0.30	.5840

Parameter	Estimate	T FOR H0: $\beta = 0$	PR > |T|
Intercept	34.285	5.09	.0001
TESW	0.395	0.79	.4291
TEHW	0.114	0.11	.9155
TEMICRO	-0.539	-0.56	.5764
TEHMICRO	-1.998	-2.42	.0162
TYPE ST	10.768	1.91	.0571
TYPE SF	16.245	2.22	.0274
TYPE NT	7.501	1.24	.2175
USAGE PATTERN	0.408	2.49	.0135
COMPUTER LITERACY	0.051	0.55	.5840

Figure 20. Sum of Squares F-Test for Decision Structure:

'TE-' = Technology Environments: **SW** -Software, **HW** -Hardware, **MICRO** -Office Microcomputer & **HMICRO** -Home Microcomputer;
'TYPE' = Individual User Perception and Judgment Types;
'USAGE PATTERN' = User Sophistication Usage Pattern &
'COMPUTER LITERACY' = User Sophistication Computer Literacy

Dependent Variable: **Sufficiency**

Source	Df	Sum of Squares	Mean Square	F =
Model	9	13732.240	1525.804	3.50
Error	206	89842.567	436.128	
Corrected Total	215	103574.808		
R^2 = .13258		C(P) = 10.0		PR > F = 0.0005

Source	Df	TYPE I SS	F Value =	PR > F
TESW	1	5738.377	13.16	.0004
TEHW	1	147.724	0.34	.5612
TEMIRCO	1	6.815	0.02	.9006
TEHMIRCO	1	92.383	0.21	.6458
TYPE ST	1	1169.349	2.74	.0992
TYPE SF	1	1493.022	3.42	.0657
TYPE NT	1	3333.777	7.64	.0062
COMPUTER LITERACY	1	1379.589	3.16	.0768
USAGE PATTERN	1	344.200	0.79	.3754

Source	Df	TYPE III SS	F Value =	PR > F
TESW	1	1782.081	4.09	.0445
TEHW	1	104.256	0.24	.6254
TEMIRCO	1	1.570	0.00	.9522
TEHMIRCO	1	73.915	0.17	.6810
TYPE ST	1	5236.031	12.01	.0006
TYPE SF	1	4220.423	9.68	.0021
TYPE NT	1	3096.012	7.10	.0083
COMPUTER LITERACY	1	1723.789	3.95	.0481
USAGE PATTERN	1	344.200	0.79	.3754

Parameter	Estimate	T FOR H0: $\beta = 0$	PR > |T|
Intercept	27.030	4.06	.0001
TESW	0.974	2.02	.0445
TEHW	0.510	0.49	.6254
TEMICRO	-0.055	-0.06	.9522
TEHMICRO	-0.327	-0.41	.6810
TYPE ST	19.283	3.46	.0006
TYPE SF	22.253	3.11	.0021
TYPE NT	15.876	2.66	.0083
USAGE PATTERN	-0.141	-0.89	.3754
COMPUTER LITERACY	0.179	1.99	.0481

Figure 21. Sum of Squares F-Test for Information Sufficiency:

'TE-' = Technology Environments: SW -Software, HW -Hardware, MICRO -Office Microcomputer & HMICRO -Home Microcomputer;
'TYPE' = Individual User Perception and Judgment Types;
'USAGE PATTERN' = User Sophistication Usage Pattern &
'COMPUTER LITERACY' = User Sophistication Computer Literacy

Dependent Variable: Reliability

Source	Df	Sum of Squares	Mean Square	F =
Model	9	14749.141	1638.7935	3.57
Error	206	94604.890	459.247	
Corrected Total	215	109354.032		
R^2 = .1348		C(P) = 10.0		PR > F = 0.0004

Source	Df	TYPE I SS	F Value =	PR > F
TESW	1	7326.677	15.95	.0001
TEHW	1	425.206	0.93	.3371
TEMIRCO	1	247.628	0.54	.4636
TEHMIRCO	1	304.911	0.66	.4161
TYPE ST	1	548.952	1.00	.3186
TYPE SF	1	540.293	1.18	.2793
TYPE NT	1	838.061	1.82	.1782
COMPUTER LITERACY	1	3488.712	7.60	.0064
USAGE PATTERN	1	1118.696	2.44	.1201

Source	Df	TYPE III SS	F Value =	PR > F
TESW	1	1665.317	3.63	.0583
TEHW	1	396.745	0.86	.3537
TEMIRCO	1	63.828	0.14	.7097
TEHMIRCO	1	315.050	0.69	.4085
TYPE ST	1	1427.137	3.11	.0794
TYPE SF	1	1106.049	2.41	.1222
TYPE NT	1	653.907	1.42	.2341
COMPUTER LITERACY	1	4594.799	10.01	.0018
USAGE PATTERN	1	1118.696	4.44	.1201

Parameter	Estimate	T FOR H0: $\beta = 0$	PR > |T|
Intercept	40.382	5.91	.0001
TESW	0.942	1.90	.0583
TEHW	0.996	0.93	.3537
TEMICRO	-0.354	-0.37	.7097
TEHMICRO	-0.675	-0.83	.4083
TYPE ST	10.067	1.76	.0794
TYPE SF	11.392	1.55	.1222
TYPE NT	7.296	1.19	.2341
USAGE PATTERN	-0.254	-1.56	.1201
COMPUTER LITERACY	0.292	3.16	.0018

Figure 22. Sum of Squares F-Test for Information Reliability:

'TE-' = Technology Environments: **SW** -Software, **HW** -Hardware, **MICRO** -Office Microcomputer & **HMICRO** -Home Microcomputer;
'TYPE' = Individual User Perception and Judgment Types;
'USAGE PATTERN' = User Sophistication Usage Pattern &
'COMPUTER LITERACY' = User Sophistication Computer Literacy

Dependent Variable: **Relevance**

Source	Df	Sum of Squares	Mean Square	F =
Model	9	14221.117	1580.124	3.54
Error	206	91821.292	445.734	
Corrected Total	215	106042.409		
R^2 = .1348		C(P) = 10.0		PR > F = 0.0004

Source	Df	TYPE I SS	F Value =	PR > F
TESW	1	6667.764	14.96	.0001
TEHW	1	8.900	0.02	.8878
TEMIRCO	1	263.118	0.59	.4432
TEHMIRCO	1	127.429	0.29	.5934
TYPE ST	1	453.053	1.02	.3146
TYPE SF	1	673.999	1.51	.2202
TYPE NT	1	5730.718	12.86	.0004
COMPUTER LITERACY	1	296.131	0.66	.4160
USAGE PATTERN	1	0.000	0.00	.9998

Source	Df	TYPE III SS	F Value =	PR > F
TESW	1	4317.965	9.69	.0021
TEHW	1	4.355	0.01	.9213
TEMIRCO	1	278.444	0.62	.4302
TEHMIRCO	1	200.926	0.45	.5027
TYPE ST	1	6166.021	13.83	.0003
TYPE SF	1	4694.487	10.53	.0014
TYPE NT	1	5614.976	12.60	.0005
COMPUTER LITERACY	1	237.009	0.53	.4667
USAGE PATTERN	1	0.000	0.00	.9998

Parameter	Estimate	T FOR H0: $\beta = 0$	PR > |T|
Intercept	28.197	4.19	.0001
TESW	1.517	3.11	.0021
TEHW	-0.104	-0.11	.9213
TEMICRO	-0.740	-0.79	.4302
TEHMICRO	-0.539	-0.67	.5027
TYPE ST	20.926	3.72	.0003
TYPE SF	23.469	3.25	.0014
TYPE NT	21.387	3.55	.0005
USAGE PATTERN	0.000	0.00	.9998
COMPUTER LITERACY	0.066	0.73	.4667

Figure 23. Sum of Squares F-Test for Information Relevance:

'TE-' = Technology Environments: **SW** -Software, **HW** -Hardware, **MICRO** -Office Microcomputer & **HMICRO** -Home Microcomputer;
'TYPE' = Individual User Perception and Judgment Types;
'USAGE PATTERN' = User Sophistication Usage Pattern &
'COMPUTER LITERACY' = User Sophistication Computer Literacy

As a result of the partial F-test we **accept** the research hypothesis that the level of managerial user's usage is positively related to their level of structured decisions, after controlling for decision environment, information technology environment and individual user perception and judgment. As shown in Figure 20 on page 100, the partial F-test with user sophistication - usage (already including literacy) is significant at PR < .0135. However, the user's computer literacy does not perform as well. It doesn't make any contribution to the model after all other possible factors have been entered into the model. Thus, only the user's information technology usage pattern helps explain the differences observed in their decision structure; their level of computer knowledge does not play a part in explaining that variance.

Information Sufficiency Tests: The tests on information sufficiency are displayed in Figure 21 on page 101. As in the previous case, the test for significance of regression shows that at least one of the regressors makes a significant contribution (PR < .0005). Sequentially, software technology environment, perception and judgment type 'NT' make a significant contribution in the sequence in which they are introduced into the model. Individual user perception and judgment types 'SF' and 'ST,' and user sophistication - computer literacy are all borderline regressors.

However, as a result of the partial F-test we **accept** the research hypothesis that the level of managerial user's sophistication - computer literacy is positively related to their perceived level of information sufficiency, after controlling for decision environment, information technology environment, individual user perception and judgment and user sophistication - usage pattern. As shown in Figure 21 on page 101, the partial F-test with user sophistication - literacy (already including usage) is significant at PR < .0481. However, user sophistication - usage pattern does not perform as well. It doesn't make any contribution to the model after all other possible factors have been entered into the model. It is also interesting to note that software and all the psychological types make a significant contribution to the model when introduced as the last regressor.

Information Reliability Tests: The testing of the user's perceived information reliability has been displayed in Figure 22 on page 102. The test for significance of regression shows that at least one of the regressors makes a significant contribution (PR < .0004). Sequentially, information technology environment - software and user sophistication - computer literacy both make a significant contribution in the sequence in which they are introduced into the model. However, none of the other variables makes a similar or borderline contribution.

Viewing the partial F-test, we **accept** the research hypothesis that the level of managerial user's sophistication - computer literacy is positively related to their perceived level of information reliability, after controlling for decision environment, information technology environment, individual user perception and judgment and user's usage pattern. As shown in Figure 22 on page 102, the partial F-test with user sophistication - literacy (already including usage) is significant at PR < .0018. However the assessment of user sophistication - usage pattern is that it doesn't make any contribution to the model after all other possible factors have been entered into the model. Therefore, only one of the dimensions of user sophistication is important in this model.

Information Relevance Tests: Figure 23 on page 103 shows the results of the tests on relevance information attribute. The test for significance of regression shows that at least one of the regressors makes a significant contribution (PR < .0004). Sequentially, information technology environment - software and user perception and judgment type 'NT' both make a significant contribution in the sequence in which they are introduced into the model. However, none of the other variables makes a similar or borderline contribution.

As a result of the partial F-test we **can not support** the research hypothesis that the level of managerial user's sophistication is positively related to their perceived level of information relevance, after controlling for decision environment, information technology environment, individual user perception and judgment. As seen in Figure 23 on page 103, the partial F-test with the user's computer literacy (already including usage) and the user 's usage pattern (including literacy) shows that neither dimension makes a significant contribution to the model of this dependent variable. However, the assessment of the user's perception and judgment type does make a very significant contribution. This contribution is significant for all types, along with the technology software environment.

Summary: There are three major observations to be gained from this chapter. First, as a result of the factor analysis, modifications to the model structure and regression model were necessary. Second, the correlation analysis indicates that there is no serious multicollinearity present in the regression model. Third, the multivariate regression analysis findings indicate positive relationships between:

1. the user's usage pattern and structured decisions;
2. the user's computer literacy and information sufficiency; and
3. the user's computer literacy and information reliability.

The discussion and interpretation of these results will be presented in the following chapter.

Chapter 5: Discussion

This chapter discusses the results of the research in conjunction with the literature from which it was developed. The purpose is to determine what happened in the study, as well as the relation of the results to the theoretical literature. The first portion of the chapter will address the four research hypotheses. Following the discussion of the hypotheses, the implications and significance of the control variables are explained. Finally, the limitations and weaknesses of the study are addressed.

Research Hypotheses

The discussion which follows places the results in a conceptual perspective. A second purpose is to discuss the implications of these findings in relation to the relevant literature. In some cases the literature has not addressed the issues identified, and the discussion centers on a more speculative versus theoretical explanation of the results.

Hypothesis 1

Based on the findings, the first research hypothesis was accepted. That hypothesis is:

> The level of managerial users' sophistication is positively related to their level of structured decisions, after controlling for Decision Environment, Information Technology Environment, and Individual User Perception and Judgment. (ACCEPTED)

In the first hypothesis, user sophistication emerged as the only significant measure in relation to a user's perceived level of structured decisions. The user's level of computer literacy did not explain enough variance in the user's responses to be significant. Thus, the user's pattern of technology usage was important in explaining different perceived levels of structured decisions. As the decision theory laboratory studies, like Blaylock and Rees (1984), indicated the psychological make-up of the decision makers was a significant determinant in relation to approaches used in decision making. As part of the Information Technology User Model the user's perception and judgment types demonstrated significance in explaining the user's perceived level of structured decisions. Some of the functional types indicated significance in both the sequential and partial F-tests. The difference in this study is that managers who operated in an information technology environment were surveyed and they were examined in a field study as opposed to a laboratory study.

The significance of the information technology environment was represented by the software scale. Contrary to the assumption made in Whisler (1970), Cheney and Dickson (1982), and Bjorn-Anderson, Eason and Robey (1986), the hardware aspects of the information technology in the organizations did not prove to be significant. The software scale was significant, but, only in the sequential F-test. This means when this environmental scale was entered first, it was an important factor due to the amount of variance it explained. However, when the other model variables were introduced before the software scale it did not explain enough of the residual variance. Thus the regressors negated any contribution made by the software scale in the last regressor position.

These findings can be related to Galbraith's (1977a, 1977b) contingency theory of management which indicates that decision structure is a function of uncertainty or lack of information. A lack of decision information results in unstructured decisions due to an inability to clarify a situation. Based on the theories of Galbraith (1977a & 1977b) and Gorry and Scott Morton (1971), these data show that a high level of managerial information technology usage (in academic institutions) is positively associated with a high level of structured decisions. The implication is that a manager who uses information technology is also one who believes he has a high level of structured decisions. Apparently, individual managers, through their usage of information technology, are able to acquire the information they need to make decisions. This information provides needed input on variants in the decision situation, creating clearer indications of possible consequences or alternatives. According to the theory (Galbraith, 1977a, 1977b), this information reduces the uncertainty associated with the specific decision.

The argument can be raised that some managers may have more structured decisions and that the findings reflect that situation. This was considered in Chapters 2 and 3, and resulted in the measurement of this scale across types of decisions. The respondents were asked to scale their level of structured decisions in five categories so that an average measure could be obtained. Thus, a dominance in a specific area could be averaged out to obtain a more representative sample.

The findings regarding this hypothesis augment the research of others like Cheney and Dickson (1978). Now, in addition to the presences of information technology, the usage of the technology is also related to a high perceived level of structured decisions. The past literature has prescribed information system implementation as a means of providing necessary decision information to managers (Cheney & Dickson, 1978; Galbraith, 1977a; Galbraith, 1977b; and Simon, 1960). The implication of this finding is that it is not enough to have the technology present to generate this type of impact on the decision structure. Information technology is no longer a centralized organizational activity. Users are creating individualized computing environments. Thus, the impact of the technology must now be represented by the pattern of managerial usage as well as the presence of the technology. User computing has matured, and the impact of information technology is being felt at the user level of analysis.

Hypothesis 2

As a result of the findings, the second research hypothesis was not supported. The hypothesis is:

> The level of managerial users' sophistication is positively related to their perceived level of decision information relevance, after controlling for Decision Environment, Information Technology Environment, and Individual User Perception and Judgment. **(FAILED TO BE SUPPORTED)**

The results for this hypothesis were unexpected; none of the user sophistication scales demonstrated any significance in explaining a user's perceived level of decision-relevant information. The user's usage pattern and computer literacy were unimportant in relation to this information attribute. This statement applies both to the sequential and partial F-tests. Thus, in determining the relevance of information received from information technology, the user's sophistication does not play any part in that determination. The user's cognitive type, however, is important in determining the user's perceived level of relevant information. In the tests which were performed, the user's perception and judgment types were significant regressors. They were more significant than the user's sophistication in explaining the perceived differences in relevance. This could mean that information relevance is a totally subjective measure controlled by the user's psychological perception. Technical and usage skills are unimportant to the user's judgment of what is relevant to him.

The tests for the technology environment software scales also indicated significance in explaining information relevance. In both the sequential and partial F-tests, this scale demonstrated a high level of significance. The concepts of an information technology environment and the cognitive types were absent from the literature (Snavely, 1976; Godfrey & Prince, 1971; Epstein & King, 1982; Feltman, 1968; and King and Epstein, 1983). However, they emerged as important in relation to this information attribute. Gorry and Scott Morton hinted at the importance of information technology in this regard but made no definitive statement. Thus, it is important when determining information relevance to know the technical source of the information. In this study the software scale emerged as an indicator of that source.

It was hypothesized that a manager with a high level of user sophistication would obtain information which was relevant to the decision situation. In the works of Snavely (1976), Gorry and Scott Morton (1971), and Duncan (1972) this characteristic of information was seen as being important to decision-making. However, after reviewing these results it appears an erroneous assumption was made about the 'relevancy' characteristic. This and other studies (Epstein and King, 1982; and King & Epstein, 1983) assumed that information relevancy was global, i.e., the information received was either relevant or not to some generalized and unspecified point of user reference. The problem is this: Is the information relevant to the information requested or is the information relevant to the decision situation? These questions represent two different points of determination for the same information characteristic. Consider the following example. A manager determines his information requirements based on his analysis of a given decision situation. This is Simon's (1960) 'intelligence' stage. The manager then formulates information requests to gather, generate and/or process the information. This is Simon's 'design' stage. The conceptual difficulty in the information attribute literature lies in how the determination of information relevancy is made. There are two possible ways in which relevancy is determined. One is in reference to the information requested. Did the computer give the information relevant to the information request? The second is in reference to the decision situation. Is the information relevant to the situation, as anticipated prior to the request?

The items in this survey were worded to address this second type of relevance. This is the type which relies on the user's judgment more than the operation of the information technology. Thus, it is logical that the psychological functions of the user were more significant than the user's sophistication. The user's sophistication is used to obtain the information needed. The implication, however, is that even if the information received from the technology is relevant to the information request, it may not be as relevant to the situation as the user had anticipated. With this particular attribute, how relevance is determined is critical to the results. This finding also implies that both the source of the information (represented by the software scales) and the cognitive type of the manager are equally important in assessing the relevance of information. These aspects have not been addressed in previous information attribute literature.

Hypothesis 3

The third research hypothesis was accepted. That hypothesis is:

> The level of managerial users' sophistication is positively related to their perceived level of decision information reliability, after controlling for Decision Environment, Information Technology Environment, and Individual User Perception and Judgment. (ACCEPTED)

What emerges in the third hypothesis is the importance of the user's computer literacy. When examining the level of information reliability, it is the user's knowledge of information technology which is significant in explaining the co-variance in that level. It is not how much the manager uses the technology, but rather how much he understands, which determines his reliance on information as factual. A good understanding of information technology translates into a strong reliance on the information generated as being reliable. Apparently, if a manager understands how the information he uses is created, he is more apt to accept it as factual.

Psychological factors did not emerge as significant in the hypothesis. The 'ST' user type was the only borderline cognitive measure. Thus, in explaining a user's belief in the reliability of information, his understanding of the technology which produced it is more important than his psychological type. But as in previous discussions, the software scale of the technology environment again demonstrated significance in relation to this information attribute. This reinforces the previous observation that the source of information is important to the assessment of its attributes. Here, users' assessments were significantly influenced by the fact the information was computer generated.

The implication of these findings is that a user's understanding of the technical aspects of computer systems enables him to determine, to his own satisfaction, the reliability of the information generated. A high level of computer literacy results in high confidence in the numbers generated. None of the information attribute literature (Snavely, 1976; Godfrey & Prince, 1971; Epstein & King, 1982; Feltman, 1968; and King and Epstein, 1983) hints at the possible association between a user's sophistication and this information attribute assessment. Therefore, adjustments to future assessment models may be appropriate.

Hypothesis 4

As a result of the research the fourth research hypothesis was accepted. That hypothesis is:

> The level of managerial users' sophistication is positively related to their perceived level of decision information sufficiency, after controlling for Decision Environment, Information Technology Environment, and Individual User Perception and Judgment. (ACCEPTED)

The components of the Information Technology User Model were most significant in its explanation of a user's level of information sufficiency. This usage pattern again failed to demonstrate any significance. However, the user's computer literacy, cognitive type and the technology software scales all demonstrated high statistical significance. Apparently, all three of these factors are important in determining the user's perceived level of sufficiency.

In terms of the user's sophistication, a high level of computer literacy appears to help the user in his or her assessment of an acceptable level of information (i.e., sufficiency). As proposed in Chapter 2, a high level of understanding enables the user to comprehend the nuances of the technology and to extract that quantity of information necessary to support the decision situation. The implications of this finding are similar to those of previous hypotheses which looked at information attributes. None of the earlier MIS literature, which has examined information attributes, has considered the factor combination used in this study. Thus, the Information Technology User Model has implications in explaining attribute assessment.

The more general point which emerges from the last three hypotheses is that there are fine distinctions between information relevance, sufficiency and reliability, which have not been identified before. We can think of these distinctions as belonging to a range or scale of attributes. One end is anchored by the label 'factual' and is represented by the attribute of reliability. The opposite end is anchored by 'abstract' and is represented by relevance. Sufficiency is a middle attribute, somewhere between abstract and factual. If we accept this scaling, the findings take on added meaning. For example, in a given information technology environment, the more factual the attribute the more important the user's computer literacy. This was exemplified in the results on reliability and sufficiency. However, with regard to more abstract attributes the user's psychological or cognitive type emerges as more important in explaining the observed results. Theoretically, the congruence of the Information Technology User Model would be subject to the location of the attribute on this range. This rationale could explain the differences in the model's performance from attribute to attribute.

A last overall implication of the hypotheses is that the presence of an information technology source and the user's computer literacy do represent some proportion of the factors which are involved in a user's assessment of information. Thus, there is room for more conceptualization and evaluation when assessing the dimensions of information. The significance of these contextual control variables is discussed in the next section.

Control Variables

The control variables have demonstrated their importance in the Information Technology User Model. Three observations can be made regarding these variables. These are discussed below in light of the pertinent literature in this section.

1. Probably the most important implication of the control variables is in terms of previous information technology research. This study has demonstrated differences in the information technology environment. The study developed an instrument which has clearly identified four dimensions to the information technology environment (see the Information Technology En-

vironment section of Chapter 3 and Factor Analysis section of Chapter 4 for a more detailed discussion). However, Bjorn-Anderson, Eason, and Robey (1986), Cheney and Dickson (1982), Epstein and King (1982), and Whisler (1970a) did not consider differences in the information technology environment at the level at which they collected their data. The findings of this study demonstrate that there are differences in the user's perception of his information technology environment. More importantly, it has shown that those technology differences can significantly explain the differences in responses from the users of that technology. Thus, Cheney and Dickson, and Bjorn-Anderson, Eason, and Roby's assumption on information technology constancy is questionable. Traditionally, the technology environment has been treated as a constant. This study assumed a heterogeneous technology environment at the user level of analysis. The correctness of this assumption has been demonstrated, and significant variation due to the differences in the technology environment has been demonstrated in the dependent variables. Based on these results, it is not sufficient to assume information technology is constant because it is present in an organization. There appear to be two levels to the technology environment, an organizational (macro) and user (micro) level. The level of analysis thus becomes important, especially when the analysis uses data aggregated from the user's level of computing. This is due to the impact of the user's perception on macro aspects of the technology environment.

2. A second observation regarding the control variables is that with respect to the information technology environment, it appears that software systems make the greatest contribution to distinguishing the environment. The studies mentioned in the previous paragraph accepted the presence of hardware as sufficient justification to attribute research results to the impact of information technology. An alternative premise is that: it is not the hardware, but rather software which distinguishes the individual and organizational information environments today. This development is possibly an effect of the microcomputer. The user can now access very sophisticated software packages on microcomputer systems. Packages like SAS, LINDO and SPSSX, which were once strictly mainframe systems, are now available on microcomput-

ers. Thus, it can be suggested that the software has become the major differential in the user's information technology environment. So the question must be asked: is a hardware focus in MIS impact studies still completely justifiable? It is important, but is it enough and should it be the primary focus? Consider also that the software provides the point of interface with the computer user. Unfortunately, there is no previous empirical research to draw upon to confirm or refute this observation.

3. A last point which warrants discussion is the indication that the user's psychological information processing functions are very relevant to this type of MIS research. The user's abilities to perceive information from his outside world, as well as his ability to internally evaluate that information, appear to be a significant part of the user's overall information processing system. Studies in decision theory, such as Blaylock and Rees (1984), have looked at cognitive processing in relation to managers/decision-makers. However, the psychological processes which managers employ in making business decisions are the same which they employ in decisions regarding the impact of information technology. The same user information processing functions are used by managers to determine system needs, system evaluations, system quality assessment and system output judgments. Thus, as Mason and Mitroff (1973) suggested and this study indicated, the psychological or cognitive aspects of MIS users warrant investigation in looking at information systems and users.

The performance of user sophistication and the control variables support the notion that information technology systems are dynamic. The factors which influence the user go beyond the technical aspect of the hardware. The proliferation of computers and the importance of the human element have accentuated the need for more research. Thus, in the next chapter recommendation for enhancing this type of study will be presented.

Limitations and Weaknesses

This discussion will point out some of the limitations and weaknesses of this study. The limitations are those which have been imposed by the research design and statistical procedures. The weakness are the results of the methodological assumptions and procedures.

Study Limitations

The limitations of this study center on statistical and design issues. The study was narrowly designed to balance a need for measurement versus statistical control in an information technology environment. The justification for the design was presented in Chapter 2. To review briefly, the focus was to measure individual user differences and the information technology environment within an organization, while controlling for as many of the macro-organizational dimensions as possible. As a result the following limitations have been imposed on the findings:

- The findings of this project are limited to the middle managers at the academic institutions surveyed. Since all middle managers at the two sites were surveyed, the conclusions reached can be generalized to all middle managers at those locations. The upper and lower levels at those sites are not represented by the empirical results since the survey design excluded them.

- The two sites were not selected at random from the population of public universities, therefore the findings of the research cannot be generalized to all public universities. However, the results can provide an indication of what 'might' be present in other similar universities based on the theoretical model presented.

- The study does not provide any indication as to the causality of the relationships which have been identified in Chapter 4. As an exploratory type of study the intent was to identify relationships which might possibly exist. Thus the study was not methologically designed for a causality analysis. Now that the possible relationships have been empirically demonstrated, the next step would be to try to determine the cause and effect relationships in future studies.

- A last limitation is in the applicability of these findings to the private sector. Just as the study's findings were not transferable or could not be generalized to other academic institutions, the same reasoning applies to industry. These findings cannot be applied to organizations in any other sector of American business. This study gives no indication of the impact a 'profit' or 'bottom-line' business orientation would have on the relationships identified. However, we would expect to find very similar results because of the theoretical base of the model, which looks at the assessment process in a non-motivational setting. It looked at decision information assessment and structured decision levels, not at the the quality of decisions made or the motivational need to make 'good' decisions.

These limitations limit the ability to generalize the findings across populations and organizations. However, they can be used to justify similar exploratory research in other organizational settings.

Study Weaknesses

Selected weaknesses in the study have been identified which are the results of the study's conceptualization and the procedures used to collect the data. The weaknesses do not diminish the findings, but rather, provide insight into how the study could be improved.

- The most significant weakness is in the regression model's lack-of-fit R^2 (Coefficient of Determination) measure. In engineering and physical sciences this value will normally range from .25 to .80.[25] In social sciences the values are not as high, and range from .10 to .60 as an acceptable range for R^2. This model averages .1249 over the four dependent variable. Thus, on

[25] No citation was located to determine normal R^2 ranges, so, values were determined by informal discussion with researchers in these fields. The range reflects the minimum and maximum values obtained though the discussions.

the average, the multivariate regression model accounts for 12.49% of the variability in the dependent variable data. Note that R^2 does not measure the appropriateness of the linear model (Montgomery & Peck, 1982). It simply indicates the amount of variability accounted for. On the chance the regression model was overdefined, a SAS Stepwise Regression analysis was performed. None of the submodels (all combinations of regressor sets of 1 to 8 variables) proved to be any better. Thus, there appear to be factors involved in the user technology model which have not been identified in the literature and are not accounted for in this study.

- The selection of the middle manager level in the organizations was intended to focus on the 'traditional' level of MIS impact analysis. However, there are subtle nuances in different organizations when discussing 'levels' of management. Thus, even though a careful research design tried to control for these differences, some of the unexplained variance probably resulted from the decision to control for organizational level in this manner. As an alternative, an instrument to measure and identify the differences which might exist between positions at the same organizational level should be developed. The advantage to this approach is that, the instrument could be used to measure one or several levels in an organization. When used for a single level it would measure those differences which are not accounted for when a level like 'middle managers' is held constant by design, as was the case in this study.

- One inevitable point of contention surfaces concerning the use of cognitive style in the user model. These results appear to run contrary to Huber's (1983) much publicized 'Much Ado About Nothing' article. The inclusion of cognitive style in this study will surely be criticized on this basis. However, there are two very plausible defenses. First, Huber's analysis is not empirically based. In other words the article is a discussion of conclusions he reached without **DIRECT** quantitative analysis. Second, his comments were directed toward cognitive research in conjunction with system design, specifically, as an operational basis for such design. This study has used cognitive type in a totally different perspective, in that it has looked at the mental functions of users to understand decision making preferences rather than proposing operational design rules for information presentation. Conclusions reached in the next chapter, regarding system design, address the selection of users for involvement in the design process and NOT changes in established software engineering methods.

These observations can be the basis for improving future research paralleling this study. The final chapter will list the major conclusions which can be inferred from this study. It will also present several recommendations for improving future research based on the observations just made.

Chapter 6: Conclusions

> 'Never before, in the history of man', he remarked, 'has the world known the wonders that our generation is seeing. We live in a world of change. I face complexities, uncertainties and risks unknown to my predecessors. What I need is information and', he added, 'all they give me are reports.' - A Pharaoh of Egypt working on his pyramid. (R. I. Tricker. Effective Information Management: Developing Information Systems Strategies. Van Nostrand Reinhold, 1984: 20.)

The conclusions reached regarding this study have been divided into two areas, those applicable to research and those which will influence MIS practitioners. These conclusions relate to the purpose of the study: to examine the impact of user sophistication on previous MIS measures. These results provide a starting point for studies into the expanding role of users in information systems research.

Research Conclusions

Three major conclusions have been reached concerning MIS research. They are a direct consequence of the empirical findings, and focus on the relationship between the information technology user and the technology environment.

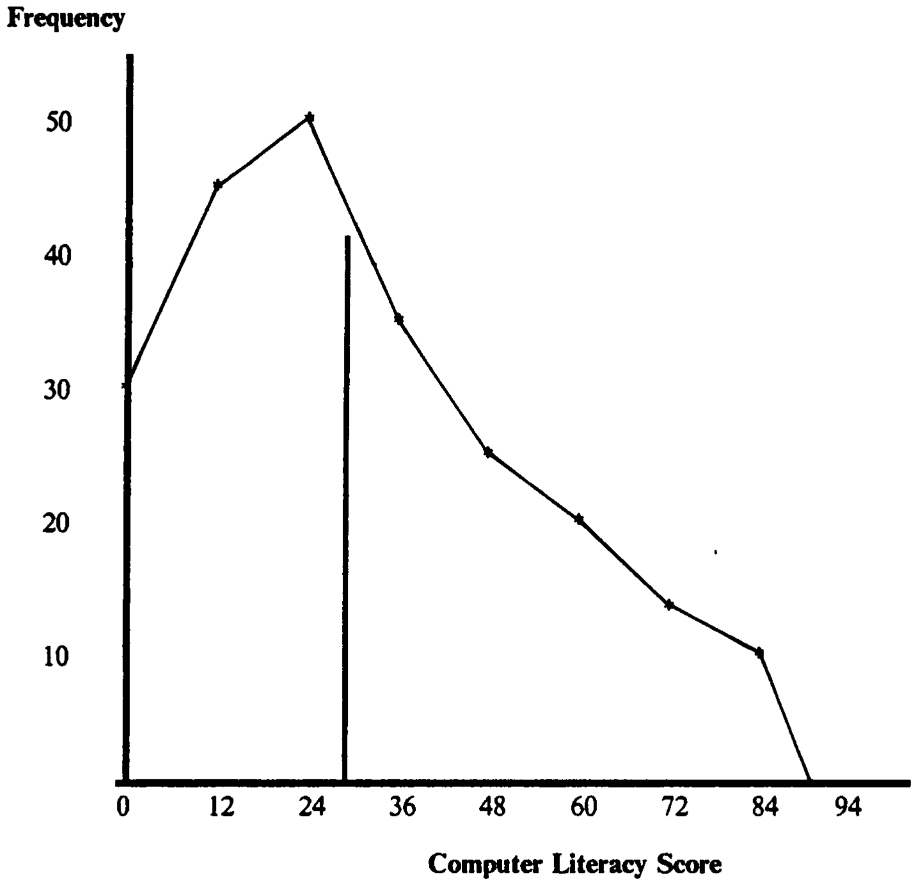

Figure 24. Computer Literacy Distribution: μ = 29.86; σ = 22.45; Min = 0; Max = 89

1. The first conclusion is that there is a positive relationship between a user's level of sophistication and his perception of traditional measures of information technology, i.e., structured decisions and information characteristics. We saw in the study that three of the four hypotheses were accepted, indicating the existence of relationships proposed in Chapter 2. Thus, it is not only the presence of information technology, but also the level of an individual user's sophistication which influences perceptions of information. Therefore, in future research into the impact of information systems, serious consideration must be given to the possible influence of user characteristics on the measured results.

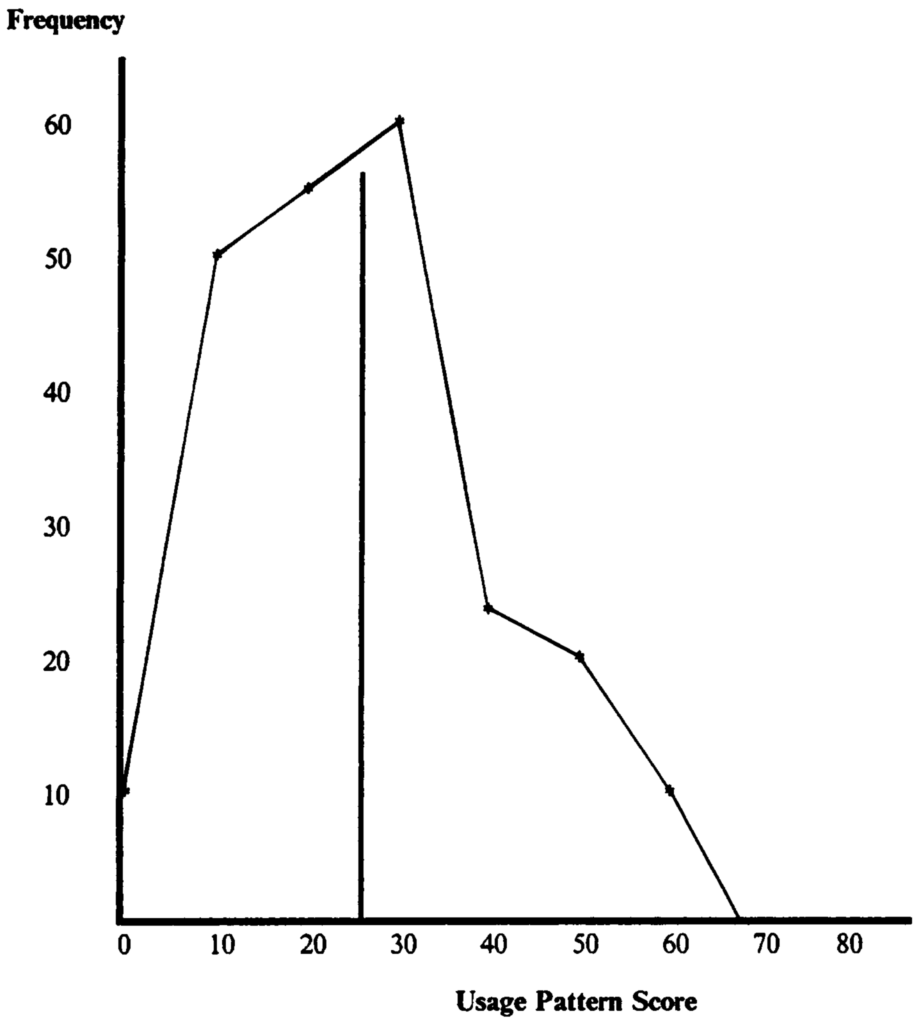

Figure 25. Usage Pattern Distribution: Usage Pattern: μ = 25.02; σ = 14.05; Min = 0; Max = 67

2. The second conclusion is that information technology users are not homogeneous, as previous research has assumed. This study has provided evidence of a great range of user literacy and usage. There were 229 users who responded to the survey. The quantitative differences in these users are indicated by the following differences in Computer Literacy and Usage Pattern Scores (see Figure 24 on page 122 and Figure 25). The ranges of these measures, especially com-

puter literacy, indicate a wide variance in the user population. Fifty percent of the users scored between 12 and 45 on computer literacy and between 14 and 33 on usage pattern. As the previous conclusion stated, these differences have also been shown to affect the impact of MIS. So in future studies, serious concerns must be raised when the 'traditional' (Whisler, 1970; Sumner, 1984; Robey, 1983; and Cheney & Dickson, 1974) bipolar user treatments are employed.

3. The third conclusion is that there are distinct and quantifiable differences in individual information technology environments and the perception of organizational information technology environments. The items used in the organizational information technology environment scales were designed so that a subject should have responded "yes" to all the items, regardless of the site. That is, all items mentioned did exist in the organization's hardware and software. Yet the average software environment scale score was 7.17 (with the maximum score being 12.0 and 8.6% scoring 0) and the average hardware environment scale score was 4.24 (with the maximum score being 6.0 and 3.2% scoring 0). In addition 76.8% of the respondents had and used a microcomputer in their office, and 52.1% used them at home. Thus, there are two important points to be made. First, the presence of information technology in an organization does not necessarily imply that it is a constant factor for all users, as Bjorn-Anderson, Eason and Robey said in 1986. Second, the introduction of information technology into an organization does not produce a similar constant effect as Cheney and Dickson postulated in 1982.

   An addendum to this conclusion is that the level of analysis must be identified when conducting research on information technology. This study identified perceived differences in organizational technology environment; it is reasonable to assume that similar differences exist between organizations. As an example, according to the instrument used in this study, Site 1's information technology environment (hardware and software) was equal to Site 2's. Is it NOT therefore permissible to assume that the technology environments are equal and sample the users for some hypothesized effect. This is because at a user's level of analysis these environments are different due to the users' perception. The physical features and software are the same, but, as this study has indicated, the user perceives differences and that perception does make a significant statistical difference. Thus, to assume a constant environment due to organizational features **AND** collect data from the user's level can possibly yield erroneous findings.

To summarize, based on these conclusions a serious look must be taken at current MIS research practices with regard to the treatment of users and their information technology environment. The Information Technology User Model has shown that information systems are a combination of complex factors. Single factor research which has been employed by Foster and Flynn (1984), Mock, Estrin and Vasarhelyi (1972), Blaylock and Rees (1984), and Cheney and Dickson (1982), does not explain enough of the dynamics and has the potential to adversely affect the findings due to the factors just mentioned.

Practitioner's Conclusions

In Chapter 1, two possible areas of importance, design and evaluation, were identified. The implications of the study findings for these two areas are discussed below.

- **Design** - Pressman (1982), Jackson (1975) and Wasserman (1980) have looked at the information systems design process in an attempt to design better systems. In software engineering, it is felt that through effective system design, system failures can be reduced. Commonly, failure of a 'good' design is attributed to a mismatch between the system and the organization (Lucas, 1975a). Pressman, Wasserman and Lucas, as well as others, address this issue at a macro level of analysis, that is, they look at the system fit or acceptance as a function of the organization. However, on unit and organizational[26] designs, a proportion of the information needed is ob-

[26] We are talking about large system design in this discussion.

tained from the users. The system engineers go into the organization and obtain data by interview, sampling and observation (Pressman, 1982). The potential for a problem now exists.

This study has demonstrated that a user's sophistication influences his perceptions concerning information technology. As an example consider the potential problem in designing or redesigning a system at Sites 1 and 2 to be used by their middle managers. Assume a joint development project for this example.

The following list is a division of the subjects by computer literacy. The maximum number of points on the computer literacy scale was divided into thirds. The percentage following each of the thirds indicates the proportion of the subjects with that level of computer literacy.

1. Lower third = 55% of managerial users

2. Middle third = 32% of managerial users

3. Upper third = 13% of managerial users

Now assume for the argument that the design personnel are not concerned with a user's level of 'sophistication' (currently the practice) as a criterion for being involved in the design process. Technical and information specialists, like any other technically-oriented professionals, prefer to interface with individuals who can understand the technical language of the profession. It doesn't require them to simplify their discussion. If, for example, the technically literate users are selected by the organization for involvement in the design process (because they can speak computerese or are very interested in information technology), the perceptions they inject into the systems specification and design represent only 13% of the user population. Practitioners-oriented researchers like Lucas, who are exploring the causes of failure due to system mismatch, might consider looking at this type of problem. Such a dysfunction in the information gathering process can very possibly cause a system failure, even with the best technically designed system. Therefore, when selecting users for involvement in system design, as advocated by the user-oriented design techniques, care must be exercised to obtain a representative sample of the user population.

- **Evaluation** - The same reasoning just presented applies when looking at the information system evaluation process. King and Epstein (1982 and 1983) developed an information system evaluation technique based on information attributes. This study has indicated that a user's assessment of these attributes is influenced by his level of sophistication. Thus, if a representative sample of the user population is not used for an evaluation process, the resulting evaluation may be skewed and underestimate or overestimate the system's effectiveness. If the sample is an accurate representation of the user population (in terms of the sophistication distribution), there is no problem in this regard.

The significance of this study, for the practitioner, lies in the treatment of the user. The concept of user sophistication can potentially influence the way in which information is gathered to design and evaluate information systems.

Future Recommendations

Based on the results and discussions which have been presented in this study, a number of recommendation are warranted. These recommendations are aimed at improving research.

- In the measurement of the information technology environment, future instruments should focus strictly on hardware and software factors. The items should be segmented into those applying to macro-systems (organizational mini's & mainframes) and those which apply to micro-systems (microcomputers). Instrumentation should look at the facilities available at both these levels of computing. In this way a better measure of the environment can be achieved. Previous studies have not quantitatively considered any differences in information technology. This study has shown that differences do exist, and that those differences can make a significant contribution to the findings. This study did not distinguish between the software used on microcomputer and mainframes. Also, even though the items were placed in different questions, the strong distinction in the user perceptions was not envisioned. The information technology environment was designed as a single factor construct. But the rationale for this measurement modification was based on the results obtained from the factor analysis. The hardware/software segmenting emerged as the most logical division of the environment at the macro and micro level.

- Future studies should include instrumentation to address and measure the decision environment. As mentioned in the section on weaknesses, in this study the decision environment was controlled by design. To possibly improve the R^2 of the user model and make the transition to a multiple organizational level analysis, this recommendation has been made. In terms of how to construct such an instrument, Duncan (1972) and other organizational theorists are possibly the best source of insight into how to distinguish levels of an organization. This is especially important to account for variance which potentially exists within levels of the same organization. This recommendation should be followed even when restricting the sample to a specific level of the organization.

- More research is needed to enhance the Information Technology User Model. In the section on weaknesses in this study it was mentioned that the overall R^2 was low. This first attempt has produced significant findings based on the model. However, there is much room to improve the model's conceptualization and identification of the other relevant, but unknown, factors. Much of the MIS literature attests to the interdisciplinary aspects of information systems. Thus, the key to the model's improvement might lie in an interdisciplinary approach, which solicits input from such areas as psychology, management, management science, engineering, computer science, and human factors. Thus, by use of this type of approach there is a greater chance of improving the model's R^2.

- The continuing advances in software sophistication and product availability may require that future versions of the computer literacy instrument be updated and expanded. A broader content will help to keep the scale current. Possible future content areas might include: software system analysis, system development life cycle management, and fourth generation query languages. As with any instrument, the benefit to researchers lies in providing a measure of the current state of the environment. This will be particularly important in future studies of computer literacy.

- The last recommendation is to expand this study, and look at the relationships in a private sector business context. The reasoning behind this recommendation is to address the issue of generalization. Through replications of the study, the findings can be generalized to more segments of the information technology user population. The potential for the model's usefulness lies in the context of profit-oriented businesses because it is in these organizational environments that most information technology is currently employed. In addition to the business sector, the public sector is another likely organizational setting in which to conduct this type of research. Federal and state governments are also high-volume users of computer-based information technology. Through expanded research, the generalization limitations of this study can be overcome.

In conclusion, the contribution of this study is not in the significance of the relationships **which** were identified, but in **how** they were identified. The study has developed a treatment and distinction of the user and his computing environment. Further, it has demonstrated that there are quantifiable differences in users and in their information technology environments. It has also shown that these differences influence the user's assessment of traditional information system measures. MIS practitioners and researchers should become aware of the influence these differences may be having on the results of their endeavors. Through such an understanding the potential for greater success in future endeavors can be realized.

FACTOR LOADING TABLES

The following tables list the factor loading's obtained from the Principal Component/Varimax Factor Analysis. The load factors are highlighted in **BOLD** face type corresponding to the factor in which they were included. Items which were not scaled are not highlighted in any of the possible solutions. Principal Component Patterns are listed for those constructs which were NOT rotated, and a single factor solution was employed. Rotated Patterns are listed for those constructs which were scaled using a Orthogonal Varimax Rotation.

The items are listed by instrument question. However, since each response in the Information Technology Environment instrument was a yes or no question, the factor table is therefore listed by response item and not question.

PRINCIPAL COMPONENT FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
EIGENVALUE	3.111			
PROPORTION	.6223			
Decision Structure Q1	**.817**			
Decision Structure Q2	**.779**			
Decision Structure Q3	**.783**			
Decision Structure Q4	**.727**			
Decision Structure Q5	**.833**			

VARIANCE EXPLAINED BY EACH FACTOR

FACTOR1	FACTOR2	FACTOR3	FACTOR4
3.111659			

Table 1. Factor Loading Table for Decision Structure

PRINCIPAL COMPONENT FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
EIGENVALUE	3.529			
PROPORTION	.7060			
Information Sufficiency Q1	**.839**			
Information Sufficiency Q2	**.767**			
Information Sufficiency Q3	**.858**			
Information Sufficiency Q4	**.851**			
Information Sufficiency Q5	**.879**			

VARIANCE EXPLAINED BY EACH FACTOR

FACTOR1	FACTOR2	FACTOR3	FACTOR4
3.529977			

Table 2. Factor Loading Table for Information Sufficiency

PRINCIPAL COMPONENT FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
EIGENVALUE	3.691			
PROPORTION	.7383			
Information Reliability Q1	**.870**			
Information Reliability Q2	**.846**			
Information Reliability Q3	**.845**			
Information Reliability Q4	**.841**			
Information Reliability Q5	**.891**			

VARIANCE EXPLAINED BY EACH FACTOR

FACTOR1	FACTOR2	FACTOR3	FACTOR4
3.691660			

Table 3. Factor Loading Table for Information Reliability

PRINCIPAL COMPONENT FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
EIGENVALUE	3.508			
PROPORTION	.7017			
Information Relevance Q1	**.850**			
Information Relevance Q2	**.778**			
Information Relevance Q3	**.840**			
Information Relevance Q4	**.828**			
Information Relevance Q5	**.885**			

VARIANCE EXPLAINED BY EACH FACTOR

FACTOR1	FACTOR2	FACTOR3	FACTOR4
3.508405			

Table 4. Factor Loading Table for Information Relevance

ORTHOGONAL ROTATED FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
EIGENVALUE	8.734	3.466	2.364	1.730
PROPORTION	.2680	.1050	.0716	.0525
Technology Item 1	.116	.137	**.850**	-.032
Technology Item 2	.253	.153	**.674**	-.218
Technology Item 3	.169	.046	**.593**	.171
Technology Item 4	-.046	.187	**.429**	.344
Technology Item 5	.114	.059	**.818**	.020
Technology Item 7	.100	.278	**.491**	.105
Technology Item 6	.368	.360	.371	-.363
Technology Item 8	-.034	-.016	.051	.062
Technology Item 9	.062	**.798**	.167	.146
Technology Item 10	.146	**.630**	.114	.042
Technology Item 11	.108	**.682**	.013	-.009
Technology Item 12	.086	**.612**	.116	.296
Technology Item 13	.085	**.735**	.091	.141
Technology Item 14	.218	**.699**	.161	.143
Technology Item 15	.095	**.732**	.054	-.022
Technology Item 17	.212	-.021	.110	**.521**
Technology Item 18	.177	.085	.044	**.566**
Technology Item 19	.207	.109	-.087	**.710**
Technology Item 20	.425	-.024	-.042	**.550**
Technology Item 21	.298	.096	-.029	**.555**
Technology Item 22	.300	.132	.055	**.514**
Technology Item 16	**.619**	.150	.015	.225
Technology Item 23	**.660**	.070	.201	.109
Technology Item 24	**.596**	.027	.136	.284
Technology Item 25	**.647**	.115	-.083	.165
Technology Item 26	**.656**	.115	.255	.231
Technology Item 27	**.759**	.134	.202	.034
Technology Item 28	**.681**	.135	.077	.046
Technology Item 29	**.770**	.193	.089	.110
Technology Item 30	**.682**	.036	.031	.093
Technology Item 31	**.633**	.147	.036	.293
Technology Item 32	**.715**	.050	.078	.218
Technology Item 33	**.704**	.103	.135	.027

VARIANCE EXPLAINED BY EACH FACTOR

FACTOR1	FACTOR2	FACTOR3	FACTOR4
6.3932	3.9471	3.0999	2.8559

Table 5. Factor Loading Table for Information Technology Environment

PRINCIPAL COMPONENT FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
EIGENVALUE	3.469	1.415		
PROPORTION	.3855	.1573		
MBTI Question 19	**.737**	-.222		
MBTI Question 28	**.769**	-.324		
MBTI Question 12	**.708**	.001		
MBTI Question 14	.061	**.815**		
MBTI Question 6	**.548**	.302		
MBTI Question 16	**.579**	.364		
MBTI Question 22	**.754**	-.104		
MBTI Question 23	**.330**	.573		
MBTI Question 27	**.716**	-.174		

VARIANCE EXPLAINED BY EACH FACTOR

FACTOR1	FACTOR2	FACTOR3	FACTOR4
3.4685	1.4155		

Table 6. Factor Loading Table for User Perception

PRINCIPAL COMPONENT FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
EIGENVALUE	2.505	1.557		
PROPORTION	.3130	.1947		
MBTI Question 2	**.450**	-.283		
MBTI Question 3	**.689**	-.228		
MBTI Question 23	**.641**	-.004		
MBTI Question 24	**.564**	.145		
MBTI Question 29	**.757**	-.115		
MBTI Question 20	.211	**.791**		
MBTI Question 32	.119	**.874**		
MBTI Question 17	**.679**	.032		

VARIANCE EXPLAINED BY EACH FACTOR

FACTOR1	FACTOR2	FACTOR3	FACTOR4
2.5040	1.5579		

Table 7. Factor Loading Table for User Judgment

ORTHOGONAL ROTATED FACTOR PATTERN

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
EIGENVALUE	14.6045	2.4597		
PROPORTION	.3947	.0665		
Usage Question 1	.219	**.631**		
Usage Question 2	.198	**.581**		
Usage Question 3	-.038	**.360**		
Usage Question 4	.321	**.555**		
Usage Question 5	.096	**.572**		
Usage Question 7	.331	**.568**		
Usage Question 8	.391	**.538**		
Usage Question 9	.193	**.628**		
Usage Question 10	.286	**.686**		
Usage Question 11	.221	**.596**		
Usage Question 12	.077	**.444**		
Usage Question 14	-.005	**.437**		
Usage Question 15	.044	**.781**		
Usage Question 16	.454	**.520**		
Usage Question 17	.335	**.579**		
Usage Question 18	.446	**.522**		
Usage Question 13	.058	.264		
Literacy Question 1	**.749**	.202		
Literacy Question 2	**.657**	.036		
Literacy Question 3	**.736**	.187		
Literacy Question 4	**.669**	-.046		
Literacy Question 5	**.808**	.161		
Literacy Question 6	**.719**	.280		
Literacy Question 7	**.674**	.270		
Literacy Question 8	**.719**	.183		
Literacy Question 9	**.851**	.251		
Literacy Question 10	**.637**	.128		
Literacy Question 11	**.776**	.207		
Literacy Question 12	**.609**	.187		
Literacy Question 13	**.588**	.227		
Literacy Question 14	**.694**	.310		
Literacy Question 15	**.730**	.370		
Literacy Question 16	**.664**	.352		
Literacy Question 17	**.669**	.370		
Literacy Question 18	**.593**	.391		
Literacy Question 19	**.703**	.402		
Literacy Question 20	**.660**	.285		

VARIANCE EXPLAINED BY EACH FACTOR

FACTOR1	FACTOR2	FACTOR3	FACTOR4
11.14677	5.917537		

Table 8. Factor Loading Table for User Sophistication

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