6 RESEARCH METHDOLOGIES AND MIS RESEARCH

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Abstract

This paper describes the process of conducting research emphasizing the steps of defining the research objectives and selecting an appropriate research methodology. The various research methodologies employed in MIS research are described and then compared based on their relative strengths and weaknesses. The thesis of this paper is that a clear, unambiguous statement of the research objective is necessary to enable the selection of an appropriate research methodology and that the selection of an appropriate methodology is critical to ensuring that the research will contribute to the body of knowledge in MIS.

Introduction

The objective of this paper is to describe and discuss the process of conducting research, the role of research methodologies, and the quality of current research in the Management Information Systems (MIS) field. Two fundamental assertions are made. The first is that there is a fundamental research process, and that it is applicable to all research. Each step in this process is necessary in all research projects. The extent to which a researcher remains aware of these steps significantly impacts the quality of his/her research. Skipping any step will seriously limit the study's contribution to knowledge in the field. The most critical step in the research process is the definition of the research topic. This step must produce a clear and precise statement of the objectives of the study. An unambiguously stated objective is essential in guiding the decisions and tradeoffs that are required in the next and subsequent steps.

The second assertion is that there are a large number of research methodologies that are applicable to MIS research. Given the diversity of the MIS field, it is folly to assert a "one best way" approach to conducting MIS research. However, the selection of a "best

methodology" for any particular research project is critical to the resulting quality and value of that project. The selection of the best methodology must be determined within the context of the research objective.

This paper briefly illustrates the diversity that characterizes current MIS research. Next the research process is superficially described. Countless books have been written describing each of the steps in this process and the systems within which it operates. (Selected references to a few of these works are provided.) Next, a major decision within one of the steps in the research process (research strategy) is examined. The decision is the selection of the appropriate research methodology, a methodology that will best facilitate the researcher attaining her/his stated research objectives. The key to selecting the best methodology for any research project is recognizing the available methodologies and understanding their relative strengths and weaknesses. Consequently, this section of the paper provides a comparative analysis of the vast majority of research methodologies that have
been employed in MIS research. Finally, the paper concludes with some observations and comments on current MIS research activities. These comments and observations are principally based upon the
author's experiences over the last eight years as an editor for MIS research on several journals and in conducting seminars with MIS doctoral students that focus on critically evaluating the MIS research literature. Others have put forth similar comments; for example see Dickson et al. (1980), Ives et al. (1980), and Keen (1980). These comments and observations are intended to stimulate thought and discussion.

Diversity in MIS Research

The purpose of this section is to provide a brief illustration of the diversity commonly encountered by an academic researcher in the MIS field and the consequent need to employ various research methodologies. These examples are drawn from the author's work over the last few years.

User-System Interface Studies

The objective of this research is to understand the relationships between the key variables associated with a human using MIS to accomplish a task and the resulting performance. The number of variables associated with this phenomenon is too large to be accommodated in a single study. This necessitated a program of research to integrate individual studies. For a detailed description of this program of research (PRIMIS), see Jenkins (1983). The objective of each individual study is to determine the relationships among a limited set of variables (usually three to five independents and four to six dependents). Since theoretical support exists for the inclusion of each variable and hypotheses testing is possible, the objective of this type of study is nearly identical to the basic objectives of the "scientific method" as described by Kaplan (1964). The research methodology that best supports the objective of this study is laboratory experimentation—more specifically, a laboratory simulation experiment.

Prototyping Information Systems

Prototyping, as a systems development methodology, is a relatively new phenomenon in MIS. The objective of this study is to determine the effects of prototyping on the information system under development and on the systems and user processionals engaged in the process. In this study, theory is weak, occurrences of the technique are still scarce, and application variations are numerous. The research methodology that best supports the objectives of this study is case method—multiple case studies.

4GL Operational Efficiencies

Fourth Generation Languages (4GLs), particularly those containing relational-like database management systems, have become widely used in business and industry. The appeal of 4GLs lies mainly in their ease of use. With an increasing number of 4GL systems in use, their operating efficiency under various computing and operating systems becomes a real concern. Again, this is a new and unique phenomenon involving resources not readily available in an academic environment. However, unlike the prototyping case, in this case partially controlled studies are possible with cooperating organizations. The objective of this study is to determine the operating efficiency of a specific 4GL (FOCUS) under various operating environments. The research methodology that best supports this objective is field experimentation.

Critical Success Factors (CSF)

The objective of this CSF study is to determine which factors in the MIS manager's environment are critical to her/his continued success. The research methodology that best supports this study is, perhaps obviously, opinion research.

These examples of MIS research projects are intended to demonstrate the need for academic researchers in MIS to understand and use various research methodologies.

The Research Process

The previous section illustrated the principle role of a research methodology in the research process—to support the attainment of the research objective. The research objective is developed in one step of the research process. The research methodology is selected in the next step in that process. A comprehensive illustration of the research process and the systems within which it functions is useful in further understanding the role and limitations of research methodologies. A model of the research process in the MIS field is presented in Figure 1.

Figure 1 contains the ideas of many scholars. The basic process, from idea to publication, is an amalgam of the concepts presented by authors such as Stone (1978), Kaplan (1964), Baisley and Clover (1979), and Buckley et al. (1976). The paradigm concepts are derived from Kuhn (1970). The sequential arrangement of steps through the process is, of course, an over-simplification. The feedback loops from each of the steps to any previous step illustrate the true iterative nature of the research process.

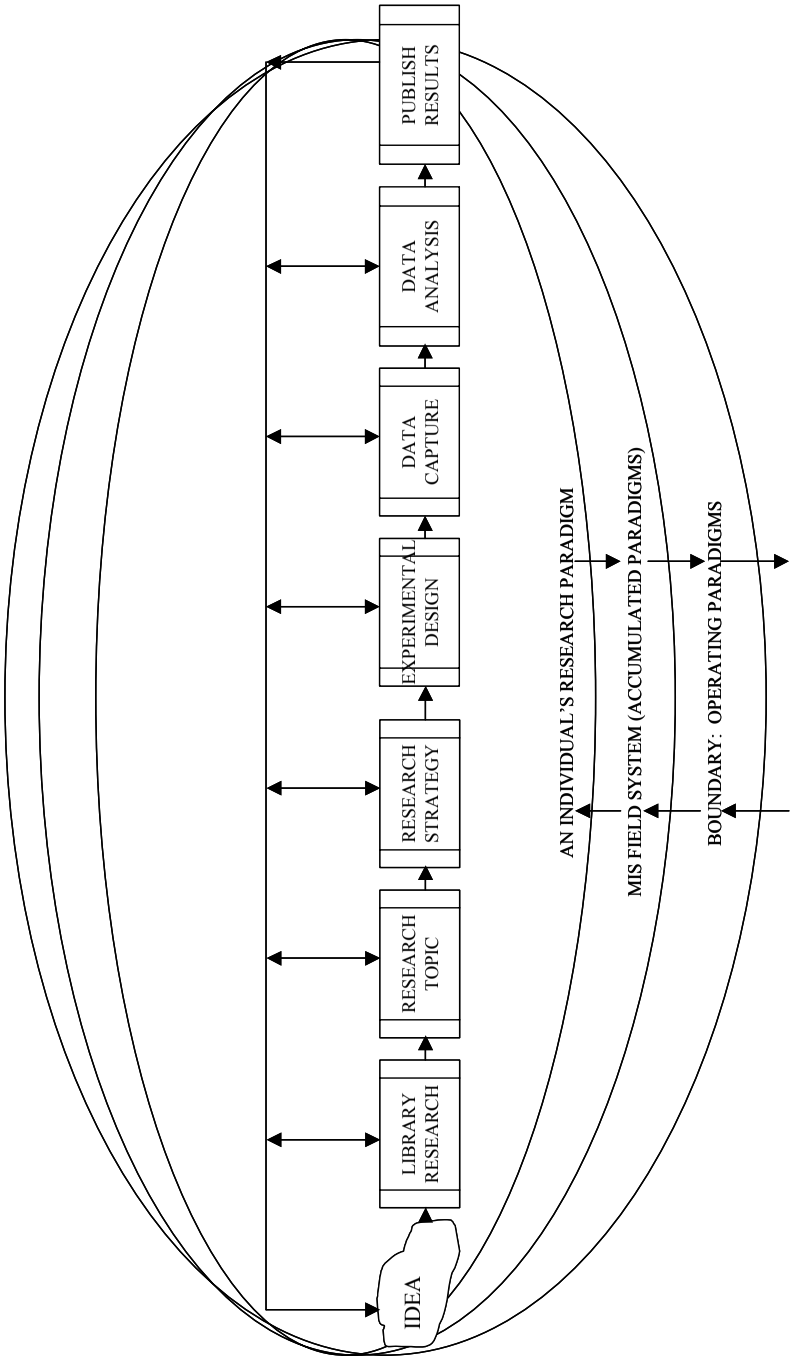

Figure 1. The Research Process in the MIS Field

A brief description of each of the steps in the research process follows:

IDEA – Getting the idea for a research project is typically unstructured. Surprisingly little of the reported research is identified as directly flowing from another researcher's statement of needed research. This initial step in the process should stimulate the researcher to the next step.

LIBRARY RESEARCH – This step (treated as a separate research methodology in some other fields) is both difficult and essential. It is difficult because of the nature of the MIS field where research is reported over a wide range of journals. Further, few quality journals are truly international in scope and few libraries contain a comprehensive collection of conference proceedings. However difficult, there is no substitute for library research in refining the initial idea to enable the next step.

RESEARCH TOPIC – Many scholars suggest that this is the most difficult step. All researchers appreciate the problem of "asking questions." See Campbell et al. (1982) for a detailed discussion of this issue. A clear, unambiguous statement of the research objective is the major output of this step.

RESEARCH STRATEGY – The successful completion of this step is contingent upon the researcher's awareness of the available research methodologies. The selection of an appropriate methodology requires the evaluation of many factors and the determination of how well they work together in supporting the research objective.

EXPERIMENTAL DESIGN – Typically, this step involves the selection of a formal experimental design. However, if a formal design is not applicable, the researcher should examine the growing number of quasi and non-experimental designs available (Campbell and Stanley 1963; Hersen and Barlow 1976). The analysis, examination and selection of research procedures also occurs at this time. This step then defines the scope of the steps which follow.

DATA CAPTURE – Typically, this step focuses on both method and procedure. Method includes tradeoffs such as survey versus sample, the kind of sample, etc. Procedure (how the data will be collected) involves tradeoffs such as questionnaire versus interview, observation versus self-reporting, etc. The implication of choice at this step is relatively well defined in the literature.

DATA ANALYSIS – This step goes beyond the appropriate application of statistical techniques (ANOVA versus MANOVA, factor versus discriminate analysis, etc.). It requires the researcher to think about the findings, both qualitative and quantitative, and interpret the findings.

PUBLISH RESULTS – This step could easily be the subject of a book. In fact, it has been, several times (for example, see Huck et al. 1974). Most important in this step is the researcher's obligation to relay to the reader what occurred in the seven previous steps as well as the research findings. This is frequently the most valuable contribution made to other researchers in the field.

This research process does not exist in a vacuum. It will, at a minimum, be influenced by (1) the individual's research paradigm, her/his understanding of the research process, and his/her integrity as a researcher, (2) the MIS field system—the accumulated paradigms, values standards, and biases typically reflected in the editorial policies and practices of the leading journals, and (3) the operating paradigms that exist in the reference disciplines. Given the interdisciplinary nature of MIS, this characteristic is almost always present. The reader may believe paradigm is too strong a term to be used here. It is intended in a general way, as opposed to any specific Kuhnian definition. As such, it is absolutely necessary in order for research to exist in MIS.

Table 1. Comparative Analysis of Research Methodologies

Rated Dimensions	Math Modeling	Exprmnt Simultn	Lab Exprmnt	Free Simultn	Field Exprmnt	Adptv Exprmnt	Field Study	Group Feedback	Opnion Research	Particptv Research	Case Study	Archival Resrch	Phil Resrch
COST:													
Initial Set-up	L-M	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	L-H	L
Marginal per Subj	N	L-H	L	L-H	M	M	M	M	L-M	L-M	L-H	N	N
Time Cost	L-H	L-H	L-M	M	M-H	M-H	M-H	M-H	M	M-H	M-H	L-H	L-H
VARIABLES:													
Strength of Ind Var	L-H	L-M	L-M	L-M	M	M	H	M-H	H	M-H	H	L	N
Range of Variables	L	M	L	M	M	M	H	H	H	M-H	L-H	L	M-H
Potential to Manipulate Ind Var	H	M-H	H	M-H	M	M-H	N	M	M	L-M	N	N	N
CONTROL:													
Potential for Testing Causal Hypotheses	H	M-H	H	M-H	M	M	L	L	L	L-M	N	L	N
Potential to Change Researcher or Ideas	L	L	L	L	M	M-H	M	L-H	H	H	H	L-M	H
Potential for Control of Confounding Vars	H	M-H	H	L	L-M	L-M	L	L	L-M	L-M	N	N	N
ARTIFACTS:													
Potential for Experimentr Expectancy	H	M-H	H	M	M-H	M	M	M	L	M	H	N	N
Potential for Demand Characteristics	N	M-H	H	M	M-H	M-H	M	M	L	L-H	H	N	N
Potential for Evaluation Apprehension	N	M-H	H	M-H	H	M-H	M	M	L-M	L-H	H	N	N
Potential for Unobstrusiveness	M-H	L	L	L-M	L-M	L-M	L-M	L-M	L	L-M	L-H	N	N

KEY: L = Low, M = Median, H = High, N = None, Qn = Quantiative, Ql = Qualitative, Pt = Past, Pr = Present, Ft = Future

Table 1 (continued)

Rated Dimensions	Math Modeling	Exprmnt Simultn	Lab Exprmnt	Free Simultn	Field Exprmnt	Adptv Exprmnt	Field Study	Group Feedback	Opnion Research	Particptv Research	Case Study	Archival Resrch	Phil Resrch
SETTING:													
Naturalness	L	L-H	L	L-H	H	H	H	M	L-H	H	H	N	N
Degree of Behavior Setting-Dependence	N	L-H	H	L-M	H	H	H	M	L	H	H	N	N
EXTERNAL VALIDITY:													
Applicability of Results Diff Popul	N	L-H	L-M	L-H	L-M	L-M	L-M	L-M	M-H	L-M	L	N	N
Applicability of Result Diff Envirn	N	L-H	L-M	L-H	L-M	M	L	L-M	L-H	L-M	L	N	N
INTERNAL VALIDITY	H	M-H	H	M	M	L-M	L	L-M	L	L	N	L-M	N
RELIABILITY	H	M-H	H	L-M	L-M	L-M	L-M	M	M-H	L	L	L-M	N
DESIGN OPTIONS	L-M	M-H	M-H	M-H	H	M-H	H	L-M	L	L-M	L	L	N
EFFECTIVENESS:													
Efficiency	H	M-H	H	L-M	M	M	L	L	L-M	L	L	M	N
Comprehensiveness	H	L-M	L	M	M	M	H	H	M	H	H	L-M	N
NATURE OF RESULTS	Qn	Qn/Ql	Ql	Qn/Ql	Qn/Ql	Ql	Ql	Ql/Qn	Qn	Ql	Ql	Ql/Qn	Ql
TIME PERSPECTIVE	Any	Pr	Pr	Pr	Pr	Pr	Pr	Pr/Ft	Pr/Ft	Pr	Pr	Pt	Any

KEY: L = Low, M = Median, H = High, N = None, Qn = Quantiative, Ql = Qualitative, Pt = Past, Pr = Present, Ft = Future

Research Methodologies

The exact number of different research methodologies that have been applied in the MIS field is unknown. Thirteen have been identified and defined in this paper. These thirteen are distinguished from each other on the basis of twelve categories containing a total of 24 dimensions. A comparative analysis of the thirteen methodologies and 24 dimensions is summarized in matrix form in Table 1.

The research methodologies are primitively ordered in Table 1. This ordering from left to right is in descending order based on the strength of the methodology in hypotheses testing. This closely corresponds to the amount of control the researcher can exert over the variables (independent, dependent, and intervening), the subjects, and the experimental findings. Philosophical research is included at the far right because this strategy is adopted primarily for the generation of hypotheses.

A brief description of each of the thirteen methodologies follows.

MATH MODELING – This methodology models the "real world" and states the results as mathematical equations. It is a closed, deterministic system in which all of the independent and dependent variables are known and included in the model. Intervening variables simply are not possible and no human subject is required. J. E. McGrath's paper "Toward a Theory of Method For Research on Organization" in Mowday and Steers (1979) provides a detailed description of this methodology. This methodology is considered the highest order of methodology by many researchers. Blalock (1979) describes the evolutionary process from verbal to mathematical formulations.

EXPERIMENTAL SIMULATION – This methodology employs a closed simulation model to mirror a segment of the "real world." Human subjects are exposed to this model and their responses are recorded. The researcher completely determines the nature and timing of the experimental events. Again, McGrath deals with this methodology in Mowday and Steers and Van Horn (1973) further describes this methodology in the specific context of MIS.

LABORATORY EXPERIMENT – With this methodology, the researcher manipulates the independent variables, controls the intervening variables, and measures the effect of the independent variables on the dependent variables. Human subjects are commonly used in a laboratory setting. This methodology is described in great detail by Howard L. Fromkin and Siegfried Streufert in their article "Laboratory Experimentation" in Marvin D. Dunnette's *Handbook of Industrial and Organizational Psychology* (1976). A more basic description of this methodology and its relationship with other methodologies is provided by Eugene Stone in *Research Methods in Organizational Behavior* (1978).

FREE SIMULATION – This methodology is similar to experimental simulation, in that with both methodologies the researcher designs a closed setting to mirror the "real world" and measures the response of human subjects as they interact within the system. However, with this methodology, events and their timing are determined by both the researcher and the behavior of the human subject. Van Horn provides the best description of this methodology in the MIS context in his paper "Empirical Studies of Management Information Systems."

FIELD EXPERIMENT – This methodology guides research that takes place in a "natural setting." The researcher manipulates the independent variables while trying to

control the most important intervening variables. The researcher then measures the effects of the independent variables on the dependent variables by systematic observation of human subjects. The form of "systematic observation" is the basis for distinguishing between various forms of field studies. For detailed descriptions and comparative analyses see Thomas J. Bouchard's article "Field Research Methods: Interviewing, Questionnaires, Participant Observation, Systematic Observation, Unobtrusive Measures" in Dunnette's *Handbook of Industrial and Organizational Psychology*. Again Stone provides a less complex discussion of this methodology.

ADAPTIVE EXPERIMENT – This is a "quasi-experimental" research methodology that involves before and after measures, a control group, and non-random assignment of human subjects. Data are gathered before the independent variables are introduced, but the final form is not usually known until after the independent variables have been introduced and the "after" data has been collected. An excellent description of this methodology is provided by E. E. Lawler III (1977).

FIELD STUDY – Using this methodology the researcher does not manipulate any independent variables, but the dependent variables are systematically measured. The study is conducted in a natural setting using human subjects. Once again, McGrath's article in Mowday and Steers provides the most detailed description of this methodology.

GROUP FEEDBACK ANALYSIS – Employing this methodology, groups of human subjects complete an objective instrument for testing of the researcher's initial hypothesis. Following the statistical analysis of the collected data, the data and the analysis are discussed with the subject group to obtain their subjective evaluation. The intent is to achieve a deeper analysis than that afforded by the statistical analysis alone. This methodology allows a re-evaluation of the original hypothesis. Frank Heller provides a detailed description of this methodology in his article, "Group Feedback Analysis: A Method of Field Research" (1969).

OPINION RESEARCH – The objective of this methodology is to gather data on attitudes, opinions, impressions and beliefs of human subjects. This is accomplished by asking them (via questionnaires, interviews, etc.). This methodology allows testing of *a priori* hypotheses and offers an iterative approach to the generation of hypotheses. A good description of this methodology is contained in *Research Methodology and Business Decisions* by J. W. Buckley, M. H. Buckley and Hung-Fu Charing (1976).

PARTICIPATIVE RESEARCH – This methodology, also referred to as "action research," allows the researcher to become a part of the research—to be affected by and to affect the research. The objective with this methodology is not the finite testing of a particular hypothesis but the realization of the "human creative potential." Human subjects in this methodology are "of the essence." A detailed description of this methodology can be found in B. L. Hall's article "Participatory Research: An Approach for Change" (1975).

CASE STUDY – Using this methodology a particular subject, group of subjects or organization is observed by the researcher without intervening in any way. No independent variables are manipulated, no control is exercised over intervening variables and no dependent variables are measured. The case study attempts to capture and communicate the reality of a particular environment at a point in time. Stone (1978) and Leenders and Erskine (1978) provide a good description of this methodology.

ARCHIVAL RESEARCH – This methodology is primarily concerned with the examination of historical documents. Secondarily, it is concerned with any recorded data. All data are examined *ex post facto* by the researcher. Buckley et al. (1976) provide a good description of this methodology.

PHILOSOPHICAL RESEARCH – This methodology defines a purely mental pursuit. The researcher thinks and logically reasons causal relationships. The process is intellectual and the aim is for the flow of logic to be explicit, replicable and testable by others. Again, Buckley et al. provide a good general description of this methodology.

Each of these research methodologies has its own strengths and weaknesses. A researcher must be aware of these in order to select the methodology which will provide him/her with the highest probability of reaching his/her research objective. Selecting a research methodology typically involves the balancing of many tradeoffs and always requires judgment. Although the following 24 dimensions (organized in twelve categories) are not a complete enumeration of all possible dimensions, they do provide much of the information required in the selection process. Each of the research methodologies is rated for each of the 24 dimensions in Table l. A brief description of each of the 24 dimensions follows.

COSTS – The costs associated with research are a real and critical factor to consider when selecting a methodology. Costs are broken down into three classes. First, there are the initial setup costs. These are the monetary costs involved in initially setting up and conducting the research. Second, there are the marginal costs per subject. These are the incremental monetary costs involved in testing each additional subject. Third, there are the time costs. These are the costs measured by the time necessary to implement the methodology. For a diverse discussion of these costs see Davis and Parker (1979), Heller (1969), and Kimberly (1976).

VARIABLES – Variables are, of course, central to all research. Three aspects of the variables are considered here. First, the strength of the independent variable determines the power of the independent variable to affect the dependent variables. Second, the range of variables is the magnitude of values that the variables can assume. Third, the potential to manipulate the independent variable is the degree of freedom the researcher has to change the values of the independent variables. Note that the number of variables (independent and dependent) is not covered in this classification schema. This is because this factor is nearly always a function of the experimental design rather than the research methodology. For discussions of this issue see Hersen and Barlow (1976), Turner (1980), and Dunnette (1976).

CONTROL – There are three aspects of control that are important to most researchers. First, the potential for testing causal hypotheses is the potential for determining that changes in the independent variables cause changes in the dependent variables. Second is the potential to change the researcher's ideas or to alter the researcher's hypothesis or concepts. Third, the potential for control of the confounding variables is the control the researcher has over alternative explanations of the effects on the dependent variables, for example, the identification of intervening variables. Dunnette (1976), Blalock (1979), and Argyris (1980) provide good additional discussion of the control issue.

ARTIFACTS – Artifacts are always with the researcher; their potentials are important considerations when selecting a methodology. Four of these potentials are

included in this classification. First is the potential for experimenter expectancy effects; that is, the potential for the researcher's expectation to affect the outcome of the experiment by influencing the responses of the subjects. Second, the potential for demand characteristics is the potential for the researcher to convey perceptual cues to the subjects about the hypothesis being tested. Third, the potential for evaluation apprehension is the possibility for the responses of the subjects to be attributed to their awareness of being participants in a research study. Fourth, the potential for unobtrusiveness lies in the ability of the researcher to be inconspicuous (hidden) while conducting the research. For a further discussion of artifacts, consult Hunter et al. (1982), Orne (1962), and Argyris (1980).

SETTING – Two aspects of the research setting are distinguished here. First, naturalness is the extent to which the research setting approximates the real world. Second is the degree to which behavior is dependent. This is the potential for the research setting to influence the responses of the subjects. For detailed coverage of this issue see Bouchard in Dunnette (1976).

EXTERNAL VALIDITY – Two dimensions of external validity are evaluated here. First is the applicability of the results to different populations or sub-populations; that is, the extent to which the research findings may be generalized across populations. Second, the applicability of the results to different environments is the extent to which the research results may be generalized to other settings or environments. Stone (1978) and Elden (1976) provide further information about this issue.

INTERNAL VALIDITY – This is the potential for determining that the independent variable (and nothing else) caused the observed effects on the dependent variable. Campbell and Stanley (1963), Stone (1978), and Blalock (1979) discuss this issue in great deal.

RELIABILITY – This is the potential for the research to be repeated with the same findings; that is, the extent to which the results are free from measurement errors. For a more complete discussion, see Campbell in Dunnette (1976), Hunter et al. (1982), and Blalock (1979).

DESIGN OPTIONS – This refers to the number of experimental designs that can be employed; that is, the design options available to the researcher, e.g., pre-test/post-test, longitudinal, between-group/within-group, full-factorial/fractional, etc. For an in-depth coverage of this issue, consult Sage (1981), Daft and Wiginton (1979), Stone (1978).

EFFECTIVENESS – Two dimensions of effectiveness are represented here: efficiency and comprehensiveness. Efficiency represents the potential for the methodology to yield a large ratio of accountable information to potential information from the study. Comprehensiveness represents the potential for the methodology to yield a large ratio of the potential information from the study to the potential information inherent in the referent situation. For further discussion of this issue, refer to Nugent and Vollman (1972).

NATURE OF RESULTS – The basic taxonomy employed here is simply the distinction between a qualitative and quantitative statement of the research results. Guba (1979), Huck et al. (1974), and Hunter et al. (1982) all address this issue.

TIME PERSPECTIVE – This involves the time period for which the methodology is best suited, e.g., past, present or future. For discussion see Blalock (1979) and Kimberly (1976).

Comments

Several academics, Dickson et al. (1980) and Keen (1980), for example, have commented on the problems existing in the field of MIS. They may be correct, but I see an even more basic problem. The problem is that many MIS faculty and most MIS doctoral students are simply not research literate. That is, they are not sufficiently aware of the research process and the importance of each step in that process.

This paper has addressed two of the research steps and the relationships between them. My reason for selecting these steps is that they have been much discussed in the literature (outside of the MIS field). However, an informal review conducted last year examining MIS publications indicated (l) that nearly half of a sample of 68 articles did not contain a clear, unambiguous statement of the researcher's objective, and (2) of those that did clearly state their objectives, over one third did not then select the research strategy that best supported meeting the objectives. We appear to have a very basic problem.

Academics in MIS have a major influence on what is published as research in MIS journals. We are, in effect, the "quality control" group for our field. It appears to me we are not doing a good job. I would like our dialogue to focus on how we can begin to do better.

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