Executive Overview

This article provides practitioners with some valuable insights into the nature of MIS research. One of the more persistent research issues in our field is the value of detailed case studies. The classical research paradigm, drawn from the physical sciences, requires the proposal of a theory from which conclusions can be deduced and verified. In addition to testability, a successful scientific theory requires logical consistency and predictive power. The scientific method calls for control over experimental variables in order to measure their effects on outcomes. Mathematical rigor and replicability are esteemed in such research as a means of better assuring objectivity.

The classical research requirements cannot be met in a case study. Such a study requires the observation of uncontrolled, and often unmeasurable, events. Confounding variables typically make it exceedingly difficult to sort our causal relationships. The imposition of classical experimental controls and rigor, aimed at overcoming these problems, may require such an artificial environment that the validity of the results is called into question. And yet, detailed case studies can potentially add a great deal to our understanding of important MIS issues.

The author argues persuasively that a case study can meet the requirements of rigorous research. Theories can be proposed that can then be tested against observed results. Although control cannot be exercised over importance variables, advantage can be taken of the natural variation that occurs in the real world. The study can often be replicated in other organizations in order to subject a theory to further verification and add to its generality.

This is a very interesting and scholarly article, well worth the effort to read for the practitioner who desires a better understanding of how our experience can increase our accumulated general knowledge so that each problem encountered does not have to be treated as a unique case.
A Scientific Methodology for MIS Case Studies

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Abstract

A methodology for conducting the case study of a management information system (MIS) is presented. Suitable for the study of a single case, the methodology also satisfies the standards of the natural science model of scientific research.

This article provides an overview of the methodological problems involved in the study of a single case, describes scientific method, presents an elucidation of how a previously published MIS case study captures the major features of scientific method, responds to the problems involved in the study of a single case, and summarizes what a scientific methodology for MIS case studies does, and does not, involve.

The article also has ramifications that go beyond matters of MIS case studies alone. For MIS researchers, the article might prove interesting for addressing such fundamental issues as whether MIS research must be mathematical, statistical, or quantitative in order to be called "scientific." For MIS practitioners, the article's view of scientific method might prove interesting for empowering them to identify, for themselves, the point at which scientific rigor is achieved in an MIS research effort, and beyond which further rigor can be called into question, especially if pursued at the expense of professional relevance.

Keywords: Information systems, case studies, research methods, research design, organizational impacts

AOM Categories: K.4.3, K.6.0, K.6.1

Introduction

There is a strong case-study tradition in the academic field of management information systems (Benbasat, et al., 1987; Fulk and Dutton, 1984; Kling, 1978; Kling and Iacono, 1984; Kling and Scacchi, 1982; Kraemer, et al., 1987; Laudon, 1974; Leonard-Barton, 1987; Markus, 1983; 1986). At the same time, case researchers in general are still attempting to clarify the methodological basis upon which to conduct case studies (Benbasat, et al., 1987; Datta, 1982; Dukes, 1965; George and McKeown, 1985; Herriot, 1982; Hersen and Barlow, 1976; Huberman and Crandall, 1982; Louis, 1982; Luftans and Davis, 1982; Miles, 1979; 1982; Yin, 1981a; 1981b; 1982a; 1982b; 1984). The objective of this article is to present a scientific methodology with which to conduct case studies of management information systems (MIS). In doing so, the article applies and builds upon concepts that pertain to case-study methodology and that the author developed in his previous research (Lee, 1985; 1986; 1987b; forthcoming).

In particular, this article (1) provides an overview of the methodological problems involved in the study of a single case, (2) offers a description of scientific method, (3) elucidates how the MIS case study by Markus fits this description, (4) responds to the problems involved in the study of a single case, and (5) summarizes what the article's scientific methodology for MIS case studies does, and does not, involve.

What is science?

The formulation of a particular scientific methodology for conducting MIS case studies and identifying the methodological problems associated with this type of research depends on what is meant by "science" in the first place. In determining this meaning, there are numerous models of science from which to select. Indeed, philosophers of science — the scholars who make it their job to observe scientists and to explain what it is that scientists do — have not yet settled, among themselves, on a single model of what
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of social science (Behling, 1980, p. 483; Burrell and Morgan, 1979, p. 4; Daft, 1983, p. 539; Schon, et al., 1984, p. 9; Susman and Evered, 1978, pp. 582-583). According to this model, natural science is the ideal on which social science should model itself. There are three reasons for selecting this particular model of science.

First, among management researchers, the natural science model is a well-known and widely accepted model for conducting studies in social science. As such, the natural science model suggests itself as a useful device for introducing scholars, unfamiliar with case studies, to this type of research.

Second, many of the criticisms directed against case studies are voiced from the perspective of the natural science model. It is the critics of case studies, not scholars already working in the case-study tradition, who need to be convinced of the legitimacy of case studies. Recognizing this, the article demonstrates the legitimacy of case studies by using the standards of the critics themselves.

Third, the article recognizes that a scientific methodology, which applies the natural science model, actually complements and supports the methods traditionally associated with case studies. The natural science model is primarily a model for testing theories, not formulating theories in the first place. Methods traditionally used by case researchers to formulate theories (Bensbat, et al., 1987; Flisstread, 1970; Garfinkel, 1967; Geertz, 1973; Kirk and Miller, 1986; Lee, forthcoming; Louis, 1982; Sanday, 1979; Taylor, 1979; Van Maanen, 1979; Yin, 1981a; 1981b; 1982b; 1984) may therefore still be applied in addition to the methods specified by the natural science model. Thus, this article respects and preserves the traditional function of case studies in suggesting hunches and generating theories for later testing — a function recognized by scholars of all persuasions. Specifically, the methodology formulated in this article (1) allows MIS case researchers to continue using the tools they have traditionally used, and (2) enables MIS case researchers to conduct case studies that test theories by using the natural science model.

Methodological Problems Raised by the Study of a Single Case

In this article an MIS case study refers to the examination of a real-world MIS as it actually exists in its natural, real-world setting. In holding MIS research to the standard of the natural science model, four problems can be identified in MIS research that is conducted in the form

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1. "Is scientific advance registered by increasing probability (Carnap), by discrete verifications (the logical positivists) or falsifications (Popper), by revolutions (Kuhn), by growing consensus (Polanyi), by progressive versus degenerating research programs, conducted over long periods (Lakatos), or what? The debate goes on" (Tice and Slaven, 1983, p. 418).

2. In his article, "The Case for the Natural Science Model for Research in Organizational Behavior and Organization Theory," Behling (1980) advocates the natural science model: “Research methods similar to those used in the natural sciences have long been the norm in organizational behavior and organization theory” (p. 483). He adds: "Clearly, the authors of mainstream texts in organizational behavior and organization theory accept the natural science model of good research. Those who include research methods chapters ... clearly follow this approach and generally appear to owe an intellectual debt to Kellinger, a strong proponent of the natural science model" (p. 483).

3. On the one hand, the natural science model of social science represents a view of science taken by many (if not most) social scientists; see the quotation in the previous footnote, as well as Burrell and Morgan (1979, p. 4), Daft (1983, p. 539), Schon, et al. (1984, p. 9), and Susman and Evered (1978, pp. 582-583). On the other hand, the philosophy of science would recognize the natural science model to be a descendant of logical positivism — a view of science that philosophers of science themselves had originated, but subsequently abandoned (Bernstein, 1978; 1983; Schon, 1983, pp. 37-49). Whereas it is the article’s responsibility to point out the disparity in viewpoints of these two communities of scholars (philosophers of science on the one hand, and many (if not most) social scientists on the other), it is beyond the article’s scope to investigate the ramifications of the disparity, much less to resolve it. For a detailed examination of this matter, see Lee (1987b; forthcoming).

Practically speaking, the audience for this article — management scholars critical of, or unfamiliar with, case studies — largely subscribe to the natural science model. For this reason, an effective strategy for approaching this audience would be to proceed with a framework they already find familiar and acceptable — namely, the framework of the natural science model.
of case studies. These problems are discussed in the next four sections.

Problem 1: Making controlled observations

The first problem concerns how to make controlled observations. In testing for relationships theorized to exist among different factors, natural scientists routinely observe the influence of one factor on another factor, where the potentially confounding influences of all other factors are somehow removed or "controlled for." Laboratory experiments in the natural sciences accomplish this through the use of control groups and treatment groups. In statistical experiments, it is accomplished with the help of statistical controls, such as those available through a multivariate regression analysis. Unfortunately for the MIS case researcher, (1) the study of a real-world MIS in its real-world setting precludes, by its very nature, the laboratory controls of laboratory experiments, and (2) the study of a single case commonly yields more variables than data points — a situation that renders inapplicable the statistical controls of statistical experiments (Yin, 1981b).

Problem 2: Making controlled deductions

The second problem concerns how to make controlled deductions. Making controlled or logical deductions with mathematical propositions — as is commonly done in the natural sciences — is a standard, non-controversial practice. However, since it is rare (though certainly not undesirable) for a case study to be quantitative, the MIS case researcher is typically denied the methodological convenience of working with numerical data and mathematically stated propositions. Instead, the case researcher must somehow manage with qualitative data and verbally stated propositions. Making controlled deductions with verbal propositions (i.e., qualitative analysis), while certainly possible, is more problematic: "For quantitative data, there are clear conventions the researcher can use," such as the widely accepted and well-known rules of algebra through which the validity of mathematical deductions is known, "but the analyst faced with a bank of qualitative data has very few guidelines for protection against self-delusion... How can we be sure that [a qualitatively deduced] finding is not, in fact, wrong?" (Miles, 1979, p. 590; emphasis in the original).

Problem 3: Allowing for replicability

The third problem concerns how to allow for replicability. Research in the natural sciences is routinely replicated as a means of assuring the objectivity of the research. However, the MIS case researcher is unlikely to observe the same set of events — namely, the same configuration of individuals, groups, social structure, hardware, and software — unfold again in the same way. The non-replicability of the same observations would clearly hinder subsequent attempts by independent investigators wishing to verify the findings of a particular case study.

Problem 4: Allowing for generalizability

The fourth and last problem concerns how to allow for generalizability. An often admired quality of theories in the natural sciences is their applicability to a range of settings. (In this sense, theories in the natural sciences are said to be "nomothetic," as opposed to "idiographic"). However, the fact that the study of a single case is marked by unique and non-replicable events would make the study vulnerable to charges that its findings cannot be extended to other settings.

The following section describes a scientific methodology for MIS case studies — a methodology that follows from the natural science model. Use of this methodology allows the final section of this article to address the problems (identified above) associated with case studies.

A Description of Scientific Method

In modeling MIS case studies on natural science, we must ask: How does inquiry in natural science proceed? Specifically, what is meant by "the natural science model"?

In his classic text, Introduction to Logic, Copi (1986) provides a lucid description of the logic of reasoning used in the natural sciences. "Few propositions of science," he explains, "are directly verifiable as true. In fact, none of the important ones are. For the most part they con-
cern unobservable entities, such as molecules and atoms, electrons and protons, chromosomes and genes” (p. 483). As a result, the manner of verification in the natural sciences is indirect rather than direct. “The pattern of indirect testing or indirect verification consists of two parts. First one deduces from the proposition to be tested [the proposition being the theory] one or more other propositions capable of being tested directly [these latter propositions being the predictions]” (p. 486). In the terminology of logic, a theory’s predictions are its conclusions. “Then these conclusions are tested and are found to be either true or false.” The researcher then compares what the theory predicts and what is actually observed. “If the conclusions are false, any proposition that implies them [namely the theory] must be false also. On the other hand, if the conclusions are true, that provides evidence for the truth of the proposition being tested, which is thus confirmed indirectly” (p. 486).

Karl Popper (1968) describes the same procedure in *The Logic of Scientific Discovery*, where he calls it the deductive testing of theories (pp. 32-33, p. 60, pp. 109-111). It is deductive in the following sense. The natural scientist applies a theory (for example, “All men are mortal”) to a set of facts or initial conditions (“Socrates is a man”), from which a conclusion or prediction is deduced (“Socrates is mortal”). It is the prediction — as a deduced statement — that is then tested against an observation statement (for example, “Socrates dies”).

In this procedure, an observation that contradicts a prediction would be sufficient to cast doubt on (perhaps to the point of falsifying) the theory from which the prediction follows. On the other hand, an observation that confirms a prediction is never regarded as conclusively establishing the theory’s truth. The reason is that a different set of empirical circumstances, or initial conditions, to which the same theory may be applied would result in yet another prediction (e.g., “Plato is mortal” or “Superman is mortal”), which in turn would open up the same theory to yet another opportunity for its falsification.

Thus, the ever-present possibility for contradictory evidence to surface in a subsequent test requires that a theory always be regarded as falsifiable. Indeed, falsifiability is the demarcation criterion that Popper uses to distinguish science from non-science (pp. 40-42).

Scientific method, in the form of the deductive testing of theories, is widely known. Kuhn (1970), whose school of thought is a rival to Popper’s, expresses that “no field is potentially a science” unless its theories are cast according to “Sir Karl’s demarcation criterion” (p. 245). The now common characterization of theories, in both natural science and social science, as falsifiable, refutable, testable, or disconfirmable, is an indication of the widespread extent to which the deductive testing of theories is practiced.

Falsifiability is just one requirement that a theory must satisfy in order to be scientific. There are three additional requirements, which are all associated with the concept of the deductive testing of theories (Popper, 1968, pp. 32-33). One of these requirements is logical consistency: as long as the different predictions that may be deduced from the theory are not mutually contradictory, the theory can be said to be logically consistent. Another requirement is that the theory must be at least as explanatory, or predictive, as any competing theory. The last requirement is that the theory, while falsifiable, must survive the actual attempts made at its falsification.

In the way that scientific method appears in the natural science model, the notion of controlled observation comes into play in the last step (namely, the step where the researcher makes a comparison between what is predicted and what is observed). In this step, the researcher must be able to show that the observed effect can be attributed to the factor being tested and that the potentially confounding effects of other factors have been removed or “controlled for” (Campbell and Stanley, 1963). This article has already mentioned laboratory controls and statistical controls as examples of how observations can be made in a controlled way.

An Exemplar for Scientific MIS Case Studies

Markus’ (1983) “Power, Politics, and MIS Implementation” captures the major features of scientific method that Copi and Popper describe. As such, the MIS case study by Markus may be regarded as an exemplar for scientific MIS case studies in general, where the meaning of “scientific” is the one embodied in the natural science model.

Markus’ research is the intensive study of a single case, involving the entire configuration of
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individuals, groups, social structure, hardware, and software in the setting of an organization that she calls Golden Triangle Corporation (GTC). Through interviews and documents, Markus observes events in the way they unfolded in their natural setting at GTC.

By conducting her research in this way, Markus invokes the severe methodological problems mentioned earlier. They are the problems of: (1) how to make controlled observations, (2) how to make controlled deductions, (3) how to allow for replicability, and (4) how to allow for generalizability.

Despite these problems, the MIS case study by Markus still succeeds in crafting a theory about MIS implementation that conforms to the requirements of falsifiability, logical consistency, predictive power exceeding that of competing theories, and survival of the empirical tests aimed at falsifying it.

Markus presents three alternative theories on an equal footing and then compares the deductions (the predictions) of each against observations made in the setting at GTC. All are theories about resistance to MIS implementation efforts. The case itself involved people's resistance to GTC's newly computerized Financial Information System (FIS).

The people-determined theory involves "factors internal to the person" (p. 431). When people factors such as human nature, cognitive styles, or personality traits are incompatible with the requirements of a computerized information system, the system's intended users, according to the people-determined theory, will resist its utilization.

The system-determined theory involves "factors inherent in the application or system being implemented" (p. 431). Markus cites the following as examples of system factors that incur resistance: lack of user-friendliness, technically deficient systems, and poor ergonomic design (p. 431). According to the system-determined theory, when such factors are present, the system's intended users will resist its utilization.

The Interaction theory, the most sophisticated of the three theories, involves people factors as well as system factors. However, Markus says, "This explanation identifies neither the system nor the organizational setting as the cause of resistance, but their interaction" (p. 431). She describes the interaction theory in the following ways:

... resistance is explained as a product of the interaction of system design features with the intraorganizational distribution of power, defined either objectively, in terms of horizontal or vertical power dimensions, or subjectively, in terms of symbolism (p. 432).

Resistance-generating conditions are mismatches between the patterns of interaction prescribed by a system and the patterns that already exist in the setting into which the system is introduced (p. 438).

The primary assumption ... is that information systems frequently embody a distribution of intraorganizational power among the key actors affected by its design. Intraorganizational power is an attribute of individuals and subgroups ....

... When the introduction of a computerized information system specifies a distribution of power which represents a loss to certain participants, these participants are likely to resist the system. Conversely, when the distribution of power implied in the design of an information system represents a gain in power to participants, these participants are likely to engage in behaviors that might signify acceptance of it ....

... [A necessary condition for resistance to the implementation of a system is that] people perceive the system to represent a power loss ... (p. 442).

All three theories refer extensively to the existence of phenomena that are neither directly observable nor easily discernible: human nature, cognitive styles, personality traits, factors internal to the person, user friendliness, technical deficiency in a system, ergonomics, horizontal and vertical dimensions of intraorganizational power, power in terms of symbolism, and (perhaps most important and most directly unobservable of all) the distribution of power implied in the design of an information system. None of the three theories is therefore directly verifiable as true.

In this context, Copi's remarks on scientific method, already quoted above, are worth repeating: "Few propositions of science are directly verifiable as true. In fact, none of the important
ones are. For the most part they concern unobservable entities, such as molecules and atoms, electrons and protons, chromosomes and genes." Hence, because direct verification is not feasible, theoretical propositions are tested indirectly instead. This manner of testing involves what Popper calls the deductive testing of theories, the details of which were described earlier in the article.

As it turns out, Markus provides an exemplary demonstration of how an MIS case study is capable of carrying out the deductive testing of theories. She tests for the truth of the three theories (and for the presence of the unobservable phenomena) in the following way. Whereas the three theories refer to phenomena that are not directly observable, they nonetheless yield predictions of events that (if the given theory is true) would be observable. Thus Markus' strategy is to use the contrary theories to make contrary predictions about what would happen in the same setting. The theory that emerges unfalsified in this competition would be judged scientific.

"The people-determined theory leads to the prediction that replacing individual resisters or co-opting them by allowing them to suggest improvements to the system might reduce or eliminate resistance" (p. 437). However, resistance to the new information system persisted despite GTC's practice of job rotation and mobility. Markus gives the example of an accountant, one of the designers and advocates of the system, who had originally been working in corporate accounting and then became the controller in one of the divisions that had resisted the system all along. He subsequently came to resist the system himself. This observation falsifies the people-determined theory.

"The system-determined theory predicts that fixing technical problems eliminates resistance" (p. 437). However, the resistance continued despite corrective actions taken to address a number of major technical problems. Significantly, the problems were identified by a task force whose members were (as characterized by Markus) "resisters." The corrective actions were the installation of a larger computer with a more powerful operating system, a change in processing mode from batch to online, and a simplified method in the software by which managers could create new accounts. Markus (1983) writes, "when data were collected for this study, about one year after the last of these changes was installed, informants in the [resisting] divisions still spoke of FIS [Financial Information System]. Many felt strongly that the system should be replaced . . ." (p. 438). Markus reports no mitigation in the resistance — a mitigation that the system-determined theory predicts. These observations falsify the system-determined theory.

The interaction theory predicts that neither changing the people (by removing them, by educating them, or by attempting to coerce them), nor changing technical features of the system will reduce resistance as long as the conditions which gave rise to it persist. [The prediction is that there will be resistance as long as there are] mismatches between the patterns of interactions prescribed by a system and the patterns that already exist in the setting into which the system is introduced (Markus, 1983, p. 438).

Markus describes the interaction pattern that was already in place at GTC as consisting of autonomy experienced by the divisional accountants and dependence experienced by the corporate accountants. The divisional accountants controlled their own data (often in thick, manually maintained ledger books) and could therefore reconcile unusual situations before releasing reports. The corporate accountants had to go through the divisional accountants to obtain financial data, which was "a valued resource" (p. 438). This conflicted with the interaction pattern prescribed by FIS, under which "all financial transactions were collected into a single [computerized] database under the control of corporate accountants . . . At any time, corporate accountants had the ability to 'look into' the database and analyze divisional performance" (p. 438). Markus' observation showed resistance to FIS, just as predicted by the interaction theory.

The interaction theory satisfies the four requirements that Popper observes to be satisfied by all scientific theories. First, it is falsifiable (e.g., the interaction theory would have been falsified if Markus had observed acceptance of FIS despite the difference between the interaction pattern that was in place and the one that FIS prescribed). Second, its logical consistency is known through the mutual compatibility of the different predictions that Markus considers (pp. 437-438). Third, it is confirmed, not falsified, by
the observations in the GTC case study. Fourth, and most important, its predictions succeed, whereas the predictions of its rival theories — the people-determined theory and the system-determined theory — fail. In crafting the interaction theory so that it satisfies the four requirements, Markus not only attains her specific research goal of explaining resistance to MIS implementation efforts, but also demonstrates how an MIS case study is able to capture the major features of scientific method in the way that scientific method is embodied in the natural science model.

It must be emphasized that the conclusions drawn by Markus in her case study are only tentative at best. After all, (1) there may exist (or come into existence) some corporate accountants at GTC who, when transferred into one of the divisions, will continue to accept, and never come to resist, FIS; (2) the improvements in the technical features of the system may not yet have reached the threshold at which the resistance would diminish observably; and (3) the resistance may persist even when the interaction pattern, required by FIS, comes to be more like the interaction pattern already in place. These possibilities, however, do not weaken Markus’ case study, but actually strengthen it by emphasizing the extent of the interaction theory’s falsifiability and allowing the case researcher to improve the theory by pointing out where later surprises may occur. No scientific explanation — whether Markus’ interaction theory or a theory of physics — may ever be conclusively proven true. According to the logic of the deductive testing of theories, a theory can only be shown to be false, or not (yet) false. In scientific research, further tests are always in order.

How to make controlled observations

A critic of case research may point out, correctly, that Markus fails to utilize either laboratory controls or statistical controls when making observations to test the three theories. However, Markus solves the problem of how to make controlled observations by utilizing natural controls.

A simple but clear example of this (referred to earlier) is Markus’ test of the people-determined theory, in which a particular accountant, upon moving from his position in corporate accounting to controller in one of the divisions, changes from being an advocate of FIS to one of its resisters. This particular test “controls for” or “holds constant” the people factors by focusing on just one person (the accountant), and “varies” or “treats” the situation external to the person by observing his move from corporate accounting to a division. Thus, Markus is able to cleanly attribute the accountant’s new behavior (resistance to FIS) to the “treatment” (the change in the situation external to the accountant) rather than to the “control” (the people factors — the factors internal to the accountant). Indeed, by making this controlled observation, Markus falsifies the people-determined theory, which predicts no change in behavior where there is no change in people factors.

In utilizing natural controls and treatments to test predictions, the case researcher must do more than wait passively for desired controls and treatments to materialize. Rather, the case researcher must actively apply his or her ingenuity in order to derive predictions that take advantage of natural controls and treatments either already in place or likely to occur. For example, in Markus’ prediction concerning the people-determined theory, the control (the holding constant of people factors) is already in place by virtue of focusing on just one person, and the treatment (the variation in the environment) takes advantage of the person’s move from one part of the organization to another. In general, it is incumbent upon the case researcher to scan the empirical material for the presence of natural controls and treatments that may be incorporated into the formulation of a prediction. (This is no different from the activity of the statistician who, in utilizing a multiple regression analysis to analyze 1980 census data, scans the data to identify what factors might serve as the ap-
propriate independent variables and, hence, as the statistical controls).

MIS case researchers who wish to utilize natural controls will find themselves in good company. Investigators in some of the natural sciences, such as astronomy, geology, and human biology, are also unable to conduct laboratory experiments for obvious reasons and are therefore also prevented from utilizing laboratory controls in order to make controlled observations. Instead, these investigators routinely conduct natural experiments in which they utilize natural controls, through which they have been able to achieve impressive results (Nagel, 1979, p. 452). MIS case researchers who invoke natural controls would therefore be employing a research strategy no different from, and no less scientific than, what is employed by these natural scientists. In using natural controls, MIS case researchers would therefore be keeping within the natural science model. To pursue this line of thinking would take us beyond the scope of this article, but would lead to the conclusion that case studies can be conducted as a form of natural experiment, which is already a conventional form of research practiced in the "hard" sciences (Lee, forthcoming).

How to make controlled deductions

In qualitative analysis, as performed by Markus in her case study, how can deductions be made in a controlled (i.e., logical) way? In mathematical analysis, the validity of deductions involving mathematical propositions can be readily checked by turning to the rules of algebra. In qualitative analysis, there is no corresponding body of rules as succinct or easily applied as the rules of algebra for verifying the validity of deductions involving verbal propositions.

To respond to this problem, it must first be emphasized that mathematics is a subset of formal logic, not vice versa. Logical deductions in the general case do not require mathematics. An MIS case study that performs its deductions with verbal propositions (i.e., qualitative analysis) therefore only deprives itself of the convenience of the rules of algebra; it does not deprive itself of the rules of formal logic, to which it may therefore still turn when carrying out the task of making controlled deductions.

Indeed, Markus herself provides examples of controlled deductions involving verbal propositions. (Namely, she deduces several different, verbally expressed predictions from the three different, verbally expressed theories as applied to the verbally expressed facts of the situation at GTC.) With regard to logical form, Markus' deductions involving verbal propositions are identical to and no less valid than, the deduction of the verbal proposition, "Socrates is mortal" (the prediction) from the two other verbal propositions, "All men are mortal" (the theory) and "Socrates is a man" (the facts or initial conditions).

Like the situation pertaining to the utilization of natural controls, MIS case researchers will find themselves in good company with regard to analysis that utilizes the medium of verbal propositions, as opposed to mathematical propositions. Consider biology and the theory of evolution. For Darwin, the medium of logical deduction was words and sentences, not numbers and mathematics (Kaplan, 1964, pp. 245-246).

How to allow for replicability

How might an independent investigator go about replicating the findings of the MIS case study by Markus?

One way — perhaps the most conceptually straightforward way — would be to attempt to replicate the case study in exactly the way that Markus performs it. For the independent investigator, this would involve the attempt to apply the same three theories to the same set of initial conditions in order to deduce the same predictions as Markus, and then test these predictions against the same observations made by Markus. The obvious difficulty with this procedure is that, in an MIS case study, any observed configuration of individuals, groups, social structure, hardware, and software in a real-world setting is highly unlikely to recur and be observed again. Thus, an independent investigator could not verify the findings of the MIS case study by Markus, at least not through this conceptually straightforward procedure.

Fortunately, there is at least one alternative procedure. The independent investigator could apply the same theories as tested in the original case study to a different set of initial conditions (for example, the facts of the situation at AAA Corporation or XXX Corporation), thereby resulting in different predictions (for example, if the people-determined theory is true, then individuals who share the same people factors at XXX...
Corporation will display no difference in their level of resistance to, or acceptance of, the computerized information system at XXX, regardless of the rank and location of their position in the organization). In other words, the investigator would be working with a new prediction, "Plato is mortal," as opposed to the original prediction, "Socrates is mortal"; even though the prediction would be different; it would still be the same theory being tested. Such new predictions would call for observations different from the ones made by Markus and would therefore relieve the independent investigator of the impossible task of attempting to replicate the observations made in the original case study. Consequently, even though the observations in a particular MIS case study are non-replicable, the case study's findings (that a particular theory is confirmed or disconfirmed) would be replicable.

How to allow for generalizability

The fact that Markus' case study of GTC is marked by unique and non-replicable events renders it vulnerable to the charge that its findings cannot be extended to other settings. However, such a criticism, applied to the study of a single case, would be misplaced. A comparison to experiments conducted in the natural sciences clarifies the issue.

Consider a natural science theory that has so far been confirmed in just a single experiment (whether a laboratory, statistical, or natural experiment). Of course, the theory would not be generalizable on the basis of the single experiment, since the experiment would have tested the theory against just a single set of empirical circumstances. Instead, the theory would be generalizable to other sets of empirical circumstances only on the basis of actually being confirmed by additional experiments that test it against those other sets of empirical circumstances. The same point holds true for case studies. No theory concerning MIS would be generalizable on the basis of a single case study, since the single case study would have tested the theory against the empirical circumstances of just a single setting. Instead, the theory concerning MIS would be generalizable to other settings only on the basis of actually being confirmed by additional case studies that test it against the empirical circumstances of those other settings.

In other words, generalizability is a quality describing a theory that has been tested and confirmed in a variety of situations, whether such testing is conducted through case research, laboratory experiments, statistical experiments, or natural experiments. As such, generalizability poses no more, and no less, of a problem for MIS case research than it does for the studies conducted in the natural sciences. In taking this position, the MIS case researcher would, again, be in step with the natural science model.

What a Scientific Methodology for MIS Case Studies Does, and Does Not, Involve

In suggesting how MIS case studies might be carried out, this article has offered a scientific methodology that involves (1) the deductive testing of theories, where (2) the theory must be (a) falsifiable, (b) logically consistent, (c) more predictive than other theories, and (d) not falsified by the tests it experiences. As such, this scientific methodology is no different from, and therefore no less rigorous than, scientific methodology as it is practiced in the natural sciences.

At the same time, this article takes the position that the scientific methodology of the natural science model does not involve, as objectives, the utilization of any of the following, even though they may often be regarded (in this article's view, improperly) as necessary elements in scientific research: laboratory controls, statistical controls, mathematical propositions, and replicable observations. Instead, each one of these happens to be a means to an objective in scientific research rather than the objective itself. MIS case studies are capable of achieving the same scientific objectives through different means.

Laboratory controls and statistical controls, for example, constitute a means to controlled observation — an objective MIS case studies are able to achieve through natural controls. Likewise, mathematical propositions constitute a means to controlled or logical deduction — an objective MIS case studies are able to achieve through verbal propositions that apply the rules of formal logic, of which the rules of mathematics are but a subset. Finally, replicable observations constitute a means to the replication of a theory's confirmation or disconfirmations — an
objective MIS case studies are able to achieve by testing the same theory through new predictions, thereby calling for new observations rather than replications of old ones.

The article has also taken the position that scientific methodology does not involve generalizability based on the result of a single test, whether it is a single test taking place in an MIS case study or a single test taking place in a laboratory experiment of the natural sciences. Instead, generalizability is a product of successive testing across a range of settings, not a single test in a single setting.

It is worth emphasizing how the particular scientific framework described in this article allows us to identify some case studies as having more analytical rigor than others. There are two ways in which analytical rigor may be assessed.

First, there is simply the matter of whether a given case study explicitly addresses each of the four requirements. As a check for falsifiability, does the case study consider any predictions through which the theory of interest could be proven wrong? As a check for logical consistency, are all the predictions considered consistent with one another? As a check for empirical validity, does the case study confirm the theory through empirical testing? Finally, as a check for relative predictive power, does the case study rule out rival theories? These questions presume, of course, that the theory of interest is stated explicitly in the first place and that predictions following from the theory are also explicitly stated. MIS case studies that satisfy all four requirements explicitly and successfully are more rigorous than MIS case studies that satisfy any of the four requirements implicitly or unsuccessfully.

Table 1 compares a number of MIS case studies with respect to the four requirements. Of course, none of the cited case studies was conducted with the avowed purpose of fitting this article’s scientific framework, so any value judgments pertaining to the quality of these studies would be inappropriate. Instead, the table is intended simply as a guide for the reader who wishes to pursue additional examples of MIS case studies that illustrate, to varying extents, the scientific methodology this article has described.

The second matter pertaining to analytical rigor is one of degree. Some case studies may satisfy the four requirements better than other case studies. For instance, first, consider the requirement that the theory of interest be confirmed through empirical testing. Confirming the theory by successfully testing it through just one of its predictions would not be as rigorous as successfully testing it through several of its predictions. Likewise, confirming the theory in just one organizational setting would not be as rigorous as confirming it in two or more organizational settings. As the number of explicitly derived predictions or the number of organizational settings is increased, the theory’s degree of confirmation may also be increased.

Second, the requirement that the theory of interest be more predictive than any rival theory may, of course, be satisfied more rigorously by increasing the number of rival theories against which its predictive performance is compared. As the number of rival theories considered is increased, the theory’s degree of relative predictive power may also be increased.

Third, the requirement that the theory of interest be logically consistent may be more rigorously satisfied by increasing the number of predictions derived from it, then making sure that none of the predicted events contradicts or precludes one another. In contrast, deriving just two predictions from the theory and checking that they do not contradict each other, would provide minimal rigor. Thus, as the number of explicitly derived predictions is increased, the theory’s degree of logical consistency may also be increased.

Finally, the requirement that the theory of interest be falsifiable may be more rigorously satisfied by increasing the number of predictions derived from it and through which the theory could be proven wrong. In other words, as the number of explicitly derived predictions is increased, the theory’s degree of falsifiability may also be increased.

Campbell (1975), too, has referred to the situation of the case researcher who pursues analytical rigor in the ways just suggested. “In some sense, he has tested the theory with degrees of freedom coming from the multiple implications of any one theory” (p. 182). In other words,
Table 1. Checking MIS Case Studies Against the Four Requirements

<table>
<thead>
<tr>
<th>Case study author(s)</th>
<th>Main theory of Interest</th>
<th>Does the case study consider any predictions through which the theory could be proven wrong?</th>
<th>Are all the predictions consistent with one another?</th>
<th>Does the case study confirm the theory through empirical testing?</th>
<th>Does the case study rule out rival theories?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markus (1983)</td>
<td>&quot;Interaction&quot; theory</td>
<td>Yes*</td>
<td>Yes*</td>
<td>Yes*</td>
<td>Yes*</td>
</tr>
<tr>
<td>Kraemer, Dickhoven, Tierney and King (1987)</td>
<td>Theory of successful implementation in federal agencies</td>
<td>Yes*</td>
<td>Yes</td>
<td>No*</td>
<td>No*</td>
</tr>
<tr>
<td>Kling and Lacono (1984)</td>
<td>&quot;Organizational politics metaphor&quot;</td>
<td>Yes*</td>
<td>Possibly*</td>
<td>Yes*</td>
<td>Yes*</td>
</tr>
<tr>
<td>Laudon (1974)</td>
<td>Theory of resistance to centralized computing in state and local governments</td>
<td>Yes*</td>
<td>Yes</td>
<td>No*</td>
<td>No*</td>
</tr>
<tr>
<td>Kling (1978)</td>
<td>Theory of interplay between technical features and social setting</td>
<td>Yes*</td>
<td>Possibly*</td>
<td>Yes*</td>
<td>Yes*</td>
</tr>
<tr>
<td>Kling and Scacchi (1982)</td>
<td>&quot;Web models&quot;</td>
<td>Yes*</td>
<td>Yes</td>
<td>Yes*</td>
<td>No*</td>
</tr>
<tr>
<td>Leonard-Barton (1987)</td>
<td>Theory of factors influencing user acceptance</td>
<td>Yes*</td>
<td>Possibly*</td>
<td>Partially*</td>
<td>No*</td>
</tr>
<tr>
<td>Fulk and Dutton (1984)</td>
<td>Theory of organizational uses of video-teleconferencing</td>
<td>Not applicable*</td>
<td>Not applicable*</td>
<td>No*</td>
<td>No*</td>
</tr>
</tbody>
</table>

See explanation for responses in "Notes for Table 1 and Table 2," following Table 2.

Campbell is extending the concept of "degrees of freedom" beyond its traditional statistical meaning. There are three ways Campbell's extended notion of "degrees of freedom" can be applied to describe the analytical rigor of a case study.

First, there are the degrees of freedom in the number of predictions the case study considers. As the degrees of freedom are increased in this category, the theory's degree of falsifiability, degree of logical consistency, and degree of confirmation can all be correspondingly increased. Increasing the degrees of freedom in this category therefore allows the case study to strengthen the extent to which it satisfies three of the four requirements.⁶

Second, there are the degrees of freedom in the number of cases or organizational settings in which a given theory is tested. As the degrees of freedom are increased in this category, the theory's degree of confirmation can be correspondingly increased. Increasing the degrees of freedom in this second category therefore allows the case study to strengthen the extent to which it satisfies one of the four requirements.⁶

⁶ Since increasing the number of predictions also increases the number of different ways in which the case study's finding (e.g., that the theory of interest is confirmed) could be subsequently replicated, the degree of replicability can also be increased.

⁶ Increasing the number of cases or organizational settings also allows the degree of generalizability to be correspondingly increased. It should be noted that increasing the number of cases or organizational settings is not necessarily the same thing as increasing...
Third and last, there are the degrees of freedom in the number of rival theories against which the theory of interest is compared. As the degrees of freedom are increased in this category, the theory’s degree of relative predictive power can be correspondingly increased. Increasing the degrees of freedom in this third category therefore allows the case study to strengthen the extent to which it satisfies one of the four requirements.

the number of data points in a statistical study. The latter is often done simply to increase the “level of confidence” associated with a single, statistically inferred observation (e.g., the observation that “the true mean is different from zero”), whereas the former involves increasing the total number of observations. In other words, increasing the number of data points will increase the “degrees of freedom” only in the conventional statistical sense of this term, not in the additional senses this article is explaining.

Table 2 compares the same MIS case studies considered in Table 1 with respect to the three categories of degrees of freedom. As the table shows, the greater a case study’s degrees of freedom in each category, the greater the case study’s analytical rigor. A particular case study’s “analytical strategy” might therefore be described in terms of the number of degrees of freedom it pursues in each category.

The central concern of this article has been to address certain methodological issues pertaining to MIS case studies. However, the article’s analysis and conclusions may have ramifications that go beyond matters of MIS case studies alone. These ramifications might prove interesting to scholars and practitioners alike.

For MIS scholars, the article’s discussion of scientific method might prove interesting for its rele-
Notes for Table 1 and Table 2

* One prediction is explicitly stated (in Table II, p. 437): “Changing individuals and/or fixing technical features will have little effect on resistance.” Other predictions pertaining to the interaction theory are considered implicitly in the discussion (pp. 437-438).

* This refers to predictions that the case study treats explicitly as well as implicitly.

* See p. 438.

* The case study rules out the “people-determined” theory and the “system-determined” theory (p. 438).

* The case study states 30 predictions (these are the “propositions” on pp. 256-287). Each prediction makes it possible to refute the theorized impact of a specific variable. (See Figure A.1, p. 257, for a list of the 30 variables.)

* The case study’s objective is theory formulation, not theory testing. Still, the theory and predictions are consistent with the facts of the two cases considered (the “TRIM/MATH” computer model and the “DRI” computer model).

* Only one theory is formulated and considered.

* All predictions treated are implicit. For example, the case study states (p. 1225): “The CBIS did not simply evolve along a natural path nor did it drift, rather it was pushed in a specific direction which would increase the power and control of key actors within the organization.” Thus the reader may infer the prediction that, if the organizational politics metaphor is true, then we should observe neither evolution along a natural path, nor drift, but observe development in a direction that would increase (not decrease or keep constant) the power and control of key actors within the organization.

* The case study provides sufficient material for the reader to infer predictions (as the prediction in note * was inferred) that may then be compared.

* For example, the prediction mentioned in note * is confirmed.

* The case study rules out the technological evolution metaphor, the economic rationality metaphor, and the organizational drift metaphor (pp. 1222-1223). The reader may infer additional predictions pertaining to these three theories, that are implicit in this portion of the case study.

* The theory contains the variables of “homogeneity,” “interdependence,” and “internal integration” (pp. 67-75). The case study states four predictions explicitly: (1) “We hypothesize that ceteris paribus, the more organizations are homogeneous with respect to tasks — the production of similar products or services — the more likely they share similar environmental and internal problems, the more likely it is that they will interact with each other in dealing with shared problems, and the more likely they are to pursue collective solutions to those problems [such as sharing and using a centralized, computerized database system]” (p. 69); (2) “Here we hypothesize that high and increasing levels of interdependence among social units are conducive to higher levels of social integration among those units, and supportive of efforts attempting to increase integration [such as sharing and using a centralized, computerized database system]” (p. 71); (3) “Therefore, we hypothesize a tradeoff between homogeneity and interdependence in relation to integration of a social system. If both qualities are high in a system, increases in integration would be supported. If both are low, further integration would be most difficult. If of opposite sign, one low and the other high, the effects should tend to cancel out” (p. 72); and (4) “For these reasons we hypothesize that under conditions of high internal unit integration, resistance to system integrating efforts will be very high, and/or the terms under which such units are included into larger systems will be very favorable...Furthermore, we suggest that if resistance remains high, and if the demands of highly integrated units are very high, the integrating effort will cease or force will be resorted to” (p. 73).
Notes for Table 1 and Table 2 — continued

The study qualifies itself by taking the position that the theory "is not itself proved by the [four] case studies [but] is intended to serve as a guide to the cases" (p. 91). However, this qualification may be read as a sign of modesty, since the study (in Table 3, p. 75) offers what appears to be the favorable results of empirically testing the predictions mentioned in note *(1). Moreover, the study even describes specific sets of empirical conditions pertaining to the bureaucratic reform process and states the level of resistance predicted for each. These sets of empirical conditions are presented under the headings of the "pluralist model"; the "collegial model"; the "notables model"; and the "reputational elite model" (pp. 80-90).

All predictions treated are implicit, but the case study provides sufficient discussion for the reader to infer them. The theory of interest is that a computerized information system's impacts are a joint product of its technical features and its social setting. One prediction the reader may infer is that, if the theory is true, then deficient technical features alone will not bring about a lack of impact or a negative impact. Whereas this prediction is clearly refutable, it is confirmed by the facts the case study reports.

See p. 492.

The case study rules out the theory that either the technical features alone, or the social setting alone, can determine the impacts of a computerized information system.

The case study states five predictions (these are the propositions on p. 26).

See pp. 55-63.

The case study compares "web" models to "discrete-entity" models, but states (p. 70): "We have not organized this article to test the relative explanatory power of the discrete-entity and web models."

One prediction is explicit (p. 10): "It seems reasonable to hypothesize that the first adopters of SSA might be younger, more highly educated in the computer field, and more skilled in computer languages than their colleagues who are not yet using, and may never use, SSA." Other predictions treated are implicit.

The prediction (mentioned in note *(1)) was refuted (p. 14): "Age, type of education, and skill in Fortran and PL1 showed no relationship to SSA use." Other predictions were confirmed.

This case study avows (p. 106): "Our purpose was not to provide a controlled experimental comparison . . . , but rather to gather exploratory and descriptive data." This case study is included as a reminder that case studies may also be legitimately used for the purposes of exploratory analysis and theory generation, not just theory testing. With respect to theory generation, this particular case study may be regarded as a useful contribution toward the development of a theory of the organizational uses of video-teleconferencing.

See pp. 21-22.

See pp. 12-14.

* See pp. 40-53.
For a provocative view of the qualitative methods that are emerging in MIS research see Bjorn-Andersen (1986); Goldstein (1986); Markus (1986); Rosen (1986). These papers were presented at the panel on the "Use of Qualitative Methods in MIS Research," held at the December 1986 annual meeting of the International Conference on Information Systems.

For an introduction to the use of qualitative methods in general, see Filstead (1970); Kirk and Miller (1986); Yin (1984), as well as the December 1979 issue of Administrative Science Quarterly.

7 In the spirit typical of methodological inquiry, MIS academics are making their own research methodology their object of study. (For example, see Ein-Dor (1986); Jenkins (1986); Kauber (1988); Klein (1986); Naumann (1986); Wand and Weber (1986). These papers were presented at the Management Information Systems Researcher's Workshop, held at the November 1986 annual meeting of the Decision Sciences Institute.) This methodological inquiry addresses not only what it means for our research to be "scientific," but also such matters as the role of frameworks, epistemology, and paradigms in MIS research.

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tween quantitative and qualitative approaches have, unfortunately, become institutionalized into opposing camps. Some of the methodological concepts in this article may prove helpful in avoiding a similar fate in the academic field of MIS.

For MIS practitioners, the article's discussion of scientific method might prove interesting for de-mystifying the aura of MIS research that claims to pursue scientific rigor, whether it involves the qualitative study of a single case or the utilization of a sophisticated statistical tool such as LISREL. The discussion of scientific method especially the four requirements that a scientific theory must satisfy — may empower MIS practitioners themselves to identify the point at which scientific rigor is achieved in an MIS research effort, and beyond which further rigor, especially if pursued at the expense of professional relevance, can be called into question.

Finally, it is important to point out that, in the actual formulation of scientific knowledge, neither natural scientists nor social scientists necessarily think in terms of the formalized procedures of any model of science, including the natural science model. Lee (1987a) states: "These procedures do not address the private, mental process by which a scientist formulates scientific knowledge, but rather the public process by which the scientist will on occasion retrospectively test the truth of the already formulated knowledge for acceptance by his or her
peers" (p. 577). Kaplan (1964) refers to the former process as the actual "logic in use" by a scientist, and the latter as a "reconstructed logic" (p. 8). In recognizing the natural science model as one among many possible reconstructed logics of science, the article also recognizes the need for future research to investigate the ramifications that alternative models of science could have for MIS case-study methodology.

References


Filstead, W. *Qualitative Methodology*, Markham, Chicago, IL, 1970.


Lee, A. "Integrating positivist and interpretive approaches to organizational research," presentation at the Annual Meeting of the Southern Management Association, New Orleans, LA, November 4-7, 1987b.


Nagel, E. The Structure of Science, Hackett, Indianapolis, IN, 1979.


Yin, R. The Case Study Strategy: An Annotated Bibliography, the Case Study Institute, Washington, D.C., 1982a.


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