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The Success or Failure of Management Information Systems: A Theoretical Approach

T. Randall Curlee
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ABSTRACT

A significant amount of work has been done by various disciplines to address the reasons why modern, computerized management information systems either succeed or fail. However, much of that literature is lacking because the studies are not based on a well-defined conceptual framework and because, in those cases where conceptualizations of the problem have been made, the focus has been narrow, making it difficult to compare one approach with another.

The purpose of this report is to present a comprehensive conceptual framework of how an information system is used within an organization. This framework not only suggests how the use of an information system may translate into productivity improvements for the implementing organization but also helps to identify why a system may succeed or fail. A major aspect of the model is its distinction between the objectives of the organization in its decision to implement an information system and the objectives of the individual employees who are to use the system. A divergence between the objectives of these two groups of decision makers, as well as the relevant constraints realized by the two groups, can lead to system underutilization or misuse at the expense of the organization's overall productivity.

This report will help provide a broader framework within which previous, more focused studies can be discussed and compared. By viewing previous work within a more comprehensive framework, new insights can hopefully be made about those studies, and missing links in the assessment of the success or failure of information systems can be identified and ultimately addressed empirically.

INTRODUCTION

The revolution in computer technology and the recognition that managerial decision making can benefit from the use of this technology have resulted in the rapid development and implementation of sophisticated management information systems (MIS). Both the public and private sectors are currently adopting these new systems in an attempt to increase organizational productivity. In many cases, however, the new systems are failing to produce the productivity bonanzas expected by many system implementers and users. For example, Bailey (1986) has argued that productivity per information worker during recent years in both the goods sector and the information-intensive sector has ". . . fallen or grown more slowly than output per production worker. . . Output per hour (in all sectors) in the past few years has grown at only a fraction of its pre-1973 rate, even though almost a third of every dollar spent on business equipment now goes into information-processing and related equipment." Although the methodologies typically used to measure the economy-wide productivity impacts of information systems have come under attack recently (see Panko 1985), there is a widely held perception that office productivity has been virtually stagnant in recent years.

A significant amount of work has been done to investigate why and how a modern, computerized MIS may not meet its productivity goals. Initially, studies were focused on the adequacy of the hardware and software that comprise the technical components of the new systems. More recently, however, the focus has shifted to organizational and behavioral constraints that may limit the effectiveness of the technical components. Referring to the modern MIS, Mankin et al. (1985) concluded that "The operating procedures, implementation behaviors and user interactions are as important to the successful application of the machines as the machines themselves." Robey and Zeller (1978) suggested that the MIS ". . . may fail for behavioral reasons having little to do with a system's technical features." Further, Martin (1982) argued that "The goal of the Eighties should be to improve productivity through harmonization of people, the organization and technology."

Unfortunately, much of the work that addresses the behavioral and organizational aspects of the adoption and use of modern information systems lacks a formal conceptualization of why those issues may be important to the ultimate success or failure of the systems. Saunders (1981) has argued that several studies of organizational processes and the uses of information systems ". . . lack an underlying theoretical framework or systematic research approach." Mankin et al. (1985) state that ". . . there is not an already developed body of theory and research that can be straightforwardly applied to understanding what factors underlie successful OIS (office information system) implementation." In some cases, hypotheses are formed about the effective use of an MIS given certain organizational and behavioral parameters but are not based on any formal theory. In other cases, testable hypotheses are based on well-developed conceptualizations of how parts of organizations function or on how particular organizational or behavioral constraints may alter the use of a new system. In these studies, there is often no consideration, however, of how the conceptualizations of the more disaggregated issues relate to the organization's overall perception of whether the system is a success or failure. Further, it is often difficult to understand how the conceptualization of one part of the problem relates to the conceptualization of another part of the problem.

The purpose of this report is to address, at a fundamental level, what constitutes system success or failure. A conceptual framework is presented that suggests how a new MIS may translate into productivity increases for the implementing organization (i.e., the assumed criteria on which the system's success or failure must ultimately be judged). A major component of the conceptual framework is its distinction between the objectives of the overall organization in its decision to implement an information system and the objectives of the individual employees who are to use the system. It is argued that the objectives of individual users, as well as the constraints realized by those users, may differ considerably from the objectives against which the organization as a whole must ultimately judge the success or failure of the new system. Individuals may misuse or underutilize the system at the expense of the organization's overall productivity. The conceptual model also provides a common framework within which other more disaggregated studies of information systems can be discussed. Finally, the model facilitates the identification of organizational and behavioral issues that have not been studied heretofore but could have serious implications for MIS use.

BACKGROUND

Before we begin the discussion of our conceptual model of how an MIS may succeed or fail, a brief review of some of the recent literature on the organizational and behavioral aspects of information systems is in order. This review will help identify some of the specific organizational and behavioral factors that have been the focus of conceptual and empirical research and will also provide the basis for our more general model.

A major focus of previous work has been on how the attitudes of system users affect system use. One of the most prolific contributors to the literature on user attitudes is Henry Lucas. His 1975 book (Lucas 1975), for example, argued both conceptually and empirically that favorable user attitudes toward, and perceptions of, the MIS are associated with high levels of use of the system. Robey (1979) found several specific attitudes to be important to the success of an MIS used by an industrial sales force. Those attitudes included "(1) the value of rewards received from performance, (2) the likelihood that rewards result from performance, and (3) the likelihood that performance results from use." Robey and Zeller (1978) examined two information systems--one that "succeeded" and one that "failed"--and concluded that two types of attitudes and perceptions were particularly important to system use: (1) the effect of the new system on job performance and performance visibility and (2) the urgency and importance of the new system to the organization. The use of the system was less sensitive to perceived support by top management; relations between users and developers of the system; and user's perceptions of the effects of the MIS on interpersonal relations, organizational change, and individual goals. Paddock and Scamell (1984) concluded from their examination of different types of information systems that user attitudes are related to the purpose for which the MIS is being implemented. Attitudes were found to differ depending on the type of MIS being implemented. Conte et al. (1985) examined how attitudes toward a new medical information system changed over time, and they reached four major conclusions: (1) user attitudes toward the system became less favorable, (2) the level of job satisfaction increased, (3) user's role ambiguity and conflict decreased slightly, and (4) the daily activities of system users changed somewhat. The importance of user attitudes toward a new MIS is reinforced by a recent survey of the Fortune Top 1000 U.S. corporations (reported in Gupta 1982), which concluded that positive user attitudes are the most important factor in successful MIS development.

Other works have focused on the effects of the new MIS on power distribution within the organization. Stewart (1971) and Vergin (1971) found that interdepartmental communications increase with system use. Saunders (1981) related the use of an MIS to the determinants of departmental power and interdepartmental or horizontal communications and argued, among other things, that the MIS will increase the ability of the organization to cope with uncertainty and will decrease the substitutability of the departments whose tasks the MIS was directly designed to facilitate. With respect to the vertical distribution of power, Tonn (1984) stated that "Computer technology allows upper management to probe into the activities of organizations in new ways. At times, this activity may reduce responsibility given to mid-level managers and may, in fact, be job threatening." Along the same lines of inquiry, Cohen et al. (1979) argued the importance "between MIS as an information-gatherer and as a system to control agency behavior and administrative decision-making." They further state that "The choice of a particular MIS involves the consideration of the agency's informational objectives, the extent to which the MIS exerts control over the decision-making process, and its cost-effectiveness."

A host of additional studies have addressed other organizational and behavioral issues. For example, De Brabander and Thiers (1984) developed a theory of system use based on the axiom that the crucial factor in system success is effective communication between system users and system specialists. Markus and Pfeffer (1983) suggested that system success is a function of the degree to which the new system is consistent with (1) other sources of power in the organization, (2) the dominant organizational culture, and (3) shared judgment about the technical certainty and degree of certainty about the organization's goals and technology. Blacker and Brown (1985) used an organizational psychology approach to argue that, because organizations are social systems, different groups within the organization have different priorities for the new MIS. Culnan (1984) examined the degree to which system access is important to system success. Culnan confirmed the basic result of past studies (i.e., a positive correlation between perceived accessibility of the system and system use). The study went further, however, to conclude that accessibility is a multidimensional concept involving the physical system, the command language, and the ability to retrieve information. Culnan also concluded that perceptions of accessibility are a function of the user's prior experience with on-line systems.

Other factors studied and commonly found to be at least a partial determinant of MIS success are reviewed in Gupta (1982). In addition to the factors already discussed, Gupta states that "Most experts agree that user involvement in system planning, design, and implementation is an essential ingredient of success." Perceptions toward and attitudes about system training are crucial determinants of success. Gupta also concludes that "Objectives should be established for the computerized system." This allows for a clear understanding of individual and group responsibilities. Writing with respect to modern information systems, Mankin, et al. (1985) state that "The consensus from previous research is that the recognition of a technological opportunity in the absence of a clear organizational need to be served by such innovation is not likely to lead to successful implementation." They go on to state that it has been ". . . found that degree of specificity of organizational objectives for innovation was positively associated with implementation outcomes . . ." and that ". . . objectives involving improved outputs were more strongly associated with implementation success than objectives defined by cost reduction."

This brief review of the recent literature gives a perception of the breadth of past research into organizational and behavioral issues concerning MIS. What is less obvious from the review is how the various theories and studies can be viewed within the context of a broader conceptual framework. It is obvious that the productivity potential of modern information systems will be realized only to the extent that those systems are used effectively. It is also obvious that what constitutes an effective use of the new systems may vary from individual to individual or from organization to organization. Further, what is an appropriate use of the system from the individual's perspective may be very different from the optimal use of the system from the perspective of the overall organization.

The remainder of this report is devoted to the development of a general conceptual framework that helps to describe how an MIS can be used optimally from the perspectives of the overall organization and the individual user. The conceptual identification of the factors that distinguish one perspective from the other not only helps to identify the organizational and behavioral factors that may lead to system failure, but also possibly suggests managerial strategies that may help ensure MIS success.

THE VALUE OF INFORMATION TO INDIVIDUALS AND ORGANIZATIONS

As an introduction to how an information system contributes specifically to the productivity of an organization, and therefore how the MIS may fail in its assumed prime objective, we must address what information is and why individuals and organizations desire more information. There is a voluminous literature on the economics of information and how information is desired and used by firms and individuals. A thorough discussion of that literature is beyond both the scope of this paper and the requirements of this conceptual model. A few results from that literature are, however, required as a foundation for our conceptual model of how an MIS is used and how it may fail. [Good reviews of the literature in that area can be found in Hirshleifer and Riley (1979) and Lamberton (1984).]

Efforts to acquire information are generally perceived as non-terminal actions to help overcome uncertainty. "Informational actions are non-terminal in that a final decision is deferred while awaiting or actively seeking new evidence which will, it is anticipated, reduce uncertainty" (Hirshleifer and Riley 1979). We can disaggregate the uncertainty of the decision maker into two main categories: (1) uncertainty about the future "states of the world" ["uncertainty is reflected in the dispersion of probability weights over the possible states" (Hirshleifer and Riley 1979) and (2) uncertainty about the consequences of different actions taken, given a particular state of the world. We will refer to the first category as the probability function and to the second category as the consequence function.

At the individual level, it is assumed that actions are taken to maximize utility. If no informational actions are possible, the individual is assumed to take terminal actions, given subjective probability and consequence functions, which maximize that individual's level of expected utility. Utility is assumed to be a function of both the acts taken and the consequences of those acts. Using the Neumann-Morgenstern "expected-utility rule," the utility of each possible act can be assessed as the mathematical expectation or probability-weighted average of the utilities of the associated consequences.

However, if informational actions are possible, the individual may elect to postpone a decision on terminal actions and, instead, take non-terminal actions to acquire information about the probability and consequence functions. This additional information will allow the probability and consequence functions to be revised in a Bayesian sense. [See, for example, DeGroot (1975) for a discussion of the revision of probabilities in a Bayesian sense.] Hirshleifer and Riley (1979) show that the value of acquiring this additional evidence will depend on the "confidence or tightness" the individual has in his or her beliefs about the prior probability functions. Hirshleifer and Riley state that ". . . the higher the prior confidence the more the posterior probability distribution will resemble the prior for any given weight of evidence . . . ." and ". . . greater confidence implies attaching lesser value to acquiring evidence." In some cases, the additional information may result in the individual taking actions that would not have been taken given the prior probability distributions. In other cases, the same actions may be taken but with more confidence. In either case, the value of the additional information is necessarily nonnegative. Note that in the case of no change in actions, the risk-averse individual (normally assumed for all individuals) gains utility if the outcomes are more certain. A risk-averse individual will always prefer a sure consequence to any probabilistic combination of consequences with an expected value equal to that of the sure consequence.

From the perspective of the firm, the conventional wisdom is that actions will be taken to maximize profits. When posed with choices involving uncertainty, the impacts of information acquisition on the firm's decisions depend on the assumptions made. Rothenberg and Smith

(1971) argued that whether expected profits of the firm rise or fall given increasing uncertainty about the prices of factor inputs depends on the convexity of the profit function with respect to factor prices. With the usual assumption of diminishing returns to factor inputs, the surprising result can be reached that expected profits are greater under uncertainty than under certainty, implying little need to acquire information, at least about factor prices. Rothenberg and Smith go on to point out, however, that cases exist in which the above nonintuitive conclusion does not hold. In other words, expected profits can be shown to increase as the level of uncertainty decreases.

For our purposes, the evaluation of the firm under uncertainty is better represented by the Markowitz-type portfolio analyses. [See, for example, Markowitz (1952).] In these analyses, the firm is assumed to prefer greater mean income but less variance of income. For any given set of investment decisions, there will exist what is termed an "efficient set of portfolios." This set consists of investment opportunities that have the highest mean income for any given level of income variance. Which investment or investments the firm should choose from this efficient set of portfolios depends on the decision maker's attitudes toward risk, which is reflected by the individual's level of risk aversion. In a sense, therefore, the firm's response to uncertainty and information acquisition in the Markowitz-type framework is reduced to the decision rules of the individual or individuals within the firm or organization that make managerial decisions. Another implication of this theory is that different firms, which differ only in terms of the levels of risk aversion of the individuals within the firms, may value information in very different ways. To one organization the value of information may be high because of a high level of risk aversion, while to the other the value of information may be low because of a low level of risk aversion. The value of information may also differ because of different perceptions about the prior probability and consequence functions.

Another possible benefit of additional information that is usually not considered in the usual theoretical assessments of uncertainty and information, but which is of value to our conceptual approach, is the identification of all possible states of the world and all possible actions. It is usually assumed in the formal conceptualizations that all possible states of the world and all possible actions are known to the decision maker. This, of course, is typically not the case (Simon 1979). Therefore, information may, in addition to allowing revisions of the probability and consequence functions associated with known possible states of the world and known actions, expand the known possible states of the world and possible actions.

In a dynamic sense, the individual or firm must, of course, recognize that delays in decision making for information retrieval may be costly. Tradeoffs will therefore exist between the benefits of additional information and the costs of postponing decisions.

MANAGERIAL INFORMATION AND INFORMATION SYSTEM DEFINED

Against this background, we can discuss managerial information within the context of an information system and conceptualize how that information can be used to increase the productivity of the organization and increase (or decrease) the utility of the individual users. For our purposes, we can discuss information for managerial decision making in terms of three key parameters: information quantity, information quality, and information speed. Information quantity can be appropriately thought of as bits of data. Additional bits of data may allow the revision of the probability and/or consequence functions or may allow the identification of additional states of the world and possible actions. Information quality relates to the reliability or certainty of the bits of data available for decision making. Just as we generally conceptualize states of the world and consequences of actions to be probabilistic, we can also view the bits of information that constitute the quantity of information to be probabilistic. In other words, the owner of bits of data will have some subjective probability about the accuracy of those bits of data. Information speed concerns the time required to collect and disseminate bits of data to individual decision makers within the organization.

We can therefore conceptualize managerial information as bits of data relevant to organizational decision making which have some subjective degree of quality or accuracy and can be collected and disseminated for organizational decision making at some given speed. An extension of this conceptualization is that additional information can be said to exist when information quantity, quality, or speed increases while holding the other two parameters constant. In cases where the value of one parameter increases and another decreases, information will either increase or decrease depending on how the individual values those particular characteristics of information.

Along these same lines, we can define a new information system as the combination of capital, k, and labor, l, devoted to the provision of information for managerial decision making that (1) makes possible additional information quantity, quality, and/or speed; and/or (2) decreases the marginal cost of information quantity, quality, and/or speed. In the first case, the marginal cost with respect to the old system of information quantity, quality, and speed may remain unchanged or actually increase for additional units of information. (Beyond some point, the marginal cost of an information system to provide additional information is essentially infinite, thus defining the system's technical limits.) However, because of the new technology, more information quantity, higher information quality, and/or faster information speed are possible. In the second case, the technical limits on information quantity, quality, and speed of the new system may not exceed those of the old MIS, but the marginal costs of providing information quantity, quality, and speed are reduced.

THE PURPOSES OF A NEW MIS

This brings us to a discussion of the potential purposes of a new MIS and how a new system may contribute to the productivity of the organization. The new MIS can contribute to increased organizational productivity by fulfilling one or more of three possible purposes: (1) by increasing information quantity, quality, and/or speed, and thereby allowing for the more efficient use of inputs to the organization's production process; (2) by lowering the total cost of managerial information; and/or (3) by allowing the redistribution of organizational authority and control.

In the first case, additional information (i.e., more quantity, better quality, and/or faster speed) may allow the decision maker to allocate resources within the organization more efficiently. The quantity and speed of information can, of course, be enhanced by the capabilities of electronic data storage and transmission. We may also interpret the possibilities for new and more sophisticated analyses of data as a quantity- and speed-enhancing feature of a new MIS. These analyses take existing bits of information and create new bits of information about probability and consequence functions and about states of nature and possible actions. Possibilities range from the routine preparation of periodical reports to the exciting possibilities offered by the new "expert systems." Quality of information may be enhanced because the electronic collection, manipulation, and transmission of information may be prone to fewer errors. Quality and speed may also be improved by "screening" functions in which selected bits of information can be easily identified and segregated from the total data base.

In the second case, the productivity improvements offered by the modern MIS are realized in the reduction of resources devoted to the acquisition of managerial information, rather than in the more efficient allocation of resources to the organization's production process. In the extreme, the new MIS may be used to provide the same information quantity, quality, and speed provided by the old system, but at a lower total cost to the organization.

The increased possibilities for information quantity, quality, and speed may also allow changes in organizational authority and control. These possibilities may allow upper-level managers to oversee or monitor additional lower-level managers, which will, other things being equal, result in productivity gains. The additional informational capabilities of the new MIS may also allow changes in the levels of management at which decisions are made. On the one hand, the ability to obtain, screen, and analyze greater volumes of information may allow the concentration of decision making in the hands of fewer managers. Upper-level managers may elect to make decisions that were previously delegated to subordinates because information could not be made readily available to those upper-level managers. On the other hand, lower-level managers may be delegated additional decision making responsibilities because required information can now be made available to those managers. Other things being equal, such changes may or may not contribute to the organization's level of productivity.

THE MANAGERIAL DECISION TO IMPLEMENT A NEW MIS

The managerial decision to implement a specific information system and to use that system to meet one or more of the previously stated purposes will depend on the expected costs of the new MIS and the expected contribution of that system to the organization's goals. While the goals of the organization are difficult to separate from the goals and preferences of the individual managers that make a decision to implement a new MIS (which is a premise of our later discussion), it is necessary to do so to define a base case against which other goals can be measured and compared. It is therefore assumed for the present discussion that an organization selects an optimal information system consisting of capital k* and labor l*, which, in the case of the firm, maximizes the expected discounted future profit stream and, in the case of the public organization, maximizes the organization's long-term objectives. While there is no general agreement on what a public organization prefers to maximize or will be forced to maximize over the long term because of internal and external pressures (Drucker 1973), we assume that the overriding reason a new MIS is adopted is to increase the organization's overall productivity.

The selection of a specific system consisting of k* and l* is based, ceteris paribus, on the organization's expectations about the changes in its productivity which will result from using the new MIS to fulfill a specific set of purposes as compared to the system it replaces. It is sufficient herein to assume that the organization selects k* and l* as part of a set of the total inputs to the organization's production process. This selection is made given the organization's current state of knowledge about the expected marginal costs and marginal products of all inputs to the production process.

In the MIS selection phase, the organization chooses k*, given expectations about the marginal costs and marginal products of other inputs and the tradeoffs between the capital and labor components that define the new MIS. However, once the long-run selection of k* is made, the managerial objective turns to the short-run goal of providing l*. We assume that once the capital components of the system--system hardware and software--have been put in place, those components cannot be altered significantly in the time frame in which the success of the new MIS, defined by k* and l*, is judged.

Figure 1 presents in graphical form the short-run objective of the organization to provide labor inputs to the new system, given the selection and installation of a particular k*. The horizontal axis represents units of labor input to the new MIS. The vertical axis is a measure of the expected change in the organization's level of productivity [change in expected productivity equals v(l)], given k* and labor input l and given that all other contributing factors to the organiza-

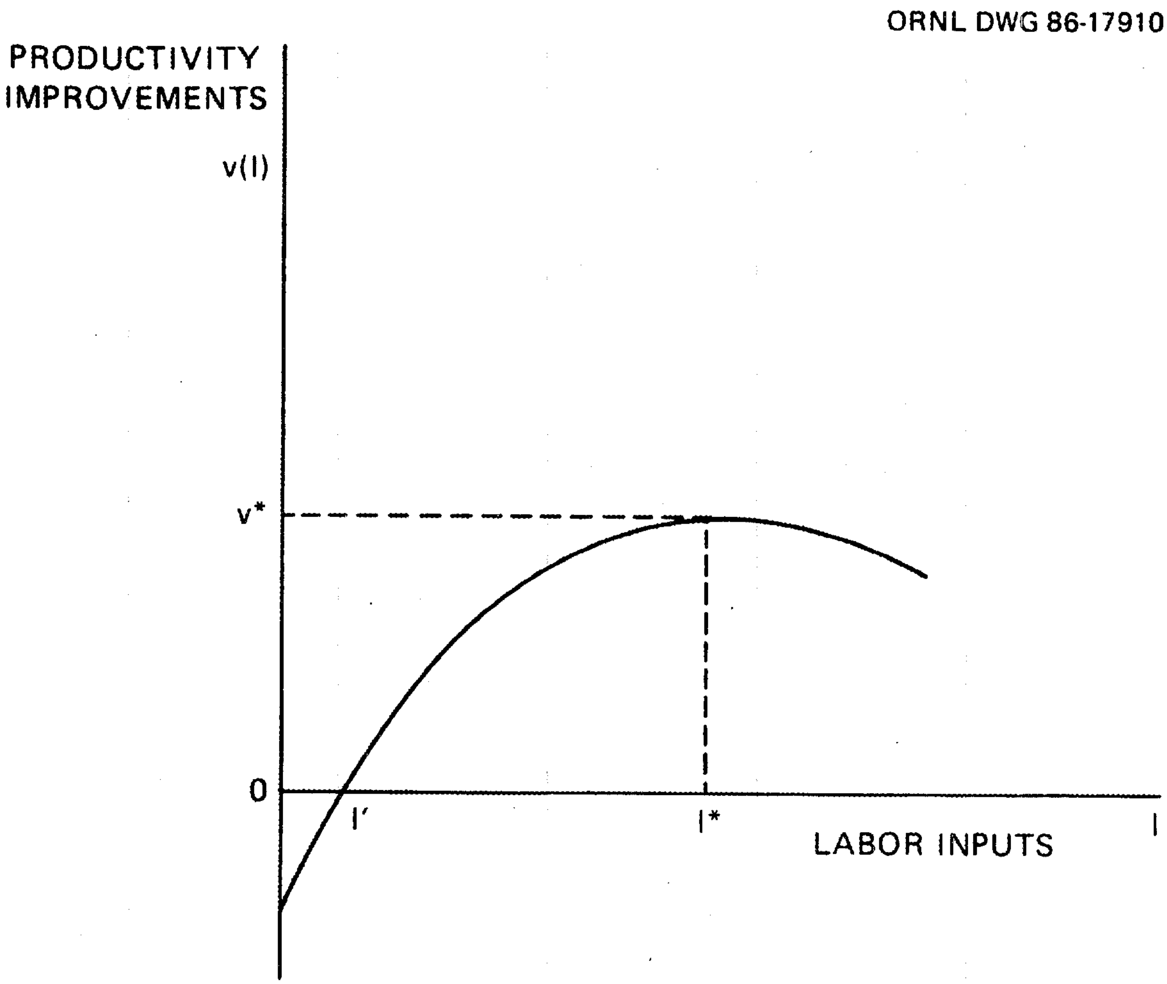

Fig. 1. The relationship between productivity improvements and labor inputs.

tion's productivity are constant. We assume additional units of labor input to the new MIS are subject to decreasing marginal returns. The organization obviously desires a level of labor input equal to 1* corresponding to the maximum expected increase in organizational productivity or, in other words, the level corresponding to

$$dv/dl = 0 \quad .$$

Note the assumption that below some minimal level of labor input, l', the use of the new system results in a net reduction in the organization's overall productivity level. In other words, a new MIS consisting of capital k* and labor inputs below l' results in lower overall productivity than that which existed with the old information system.

THE SUCCESS OR FAILURE OF A NEW MIS

The success or failure of a new MIS is relative and must be measured in relation to the expectations of the organization that implements the system. In addition, given that we have assumed that the capital component of the new MIS is difficult to change, at least in the short run, the success or failure of a new system is predominantly linked to the appropriate input of labor. Again referring to Fig. 1, let us define total success as that which occurs when productivity increases by v* corresponding to labor input l*. In other words, the expected maximum potential for productivity improvements from the new MIS is realized. Total failure occurs when the input of labor is less than l'. Any input of labor between l' and l* or greater than l* will result in partial system failure or success, depending on the perspective.

REASONS WHY AN INFORMATION SYSTEM MAY FAIL

The purpose of this section is to discuss several conceptual reasons why a new MIS may fail either partially or totally. These reasons can be divided into three main categories: (1) failures due to technological inadequacies, (2) failures due to organization constraints on the availability of labor input to the system, and (3) failures resulting from conflicts between the organization's goals and purposes for the new MIS and the preferences of individuals and groups using the system.

FAILURES RESULTING FROM INADEQUACIES OF THE CAPITAL COMPONENT

The obvious place to begin an assessment of why an MIS may fail is with the hardware and software that compose the capital component of the system. If the capital component is not adequate to respond to the intended purposes of the system, the usefulness of the MIS is obviously constrained.

Given our conceptual formulation of the problem thus far, this type of system failure can be characterized as a suboptimal selection of k. In other words, the k selected may be something different from k*. This type of problem may arise because of a failure of communication between the implementing organization and the implementer of the new system. For example, were the intended purposes of the system adequately communicated to the implementer? Did the implementer mislead the adopting organization about the technical capabilities of the new MIS? Did the intended purposes of the new system change during the implementation phase? Or did the capital component simply not function as the implementer and the implementing organization expected?

FAILURES DUE TO ORGANIZATIONAL CONSTRAINTS ON LABOR AVAILABILITY

The failure of an MIS may be attributed to a constraint imposed by the organization on the labor available for system use. In our framework discussed thus far, this failure can be characterized as a constraint on l such that the maximum labor available for system use is something less than l*.

The assessment of the specific types of constraints that can lead to insufficient labor requires a further discussion of the components of the labor input. Let us characterize the labor inputs of individual users in terms of three key parameters:

$$l = f(t, s, PFC) \quad ,$$

where t is the time the system is used by system users; s is the skill level of system users; and PFC, or Propensity for Compliance, is an index that indicates the degree to which the use of the new MIS by individual users complies with the goals of the organization. It is assumed that

$$-1 \leq PFC \leq 1 \quad .$$

When PFC is equal to 1, it is assumed that the individual users desire to use the new system in a manner that is consistent with the maximization of the organization's objectives (i.e., increasing the organization's level of productivity by using the new system). When PFC is equal to -1, it is assumed that individual users desire to use the new MIS in a way that is exactly opposite the objectives of the organization, thus minimizing rather than maximizing the organization's goals. When PFC is equal to 0, it is assumed that individual users neither desire to comply with nor oppose organizational goals. Obviously, the organization desires that PFC equal 1.

While the PFC parameter is a major focus of the following subsection, let us assume for now that PFC is equal to 1 in order to focus on potential problems associated with t and s. If the implementing organization in some way constrains t to be less than the optimal input of time, t*, or does not provide adequate resources for system training or user capital such that s cannot reach the optimal level of skill, s*, the new MIS will to some extent fail.

Skill of the system users can be constrained in various ways. For example, the implementing organization may simply not devote sufficient resources, in terms of time, educational materials, instructors, and so forth, to the training of system users. Another problem could be the timing and intensity of training. It is generally recognized that the more sophisticated or "intellectual" the technology, the more ongoing adaptive training will be required. (See, for example, Curley and Pyburn 1982.) In addition, structural constraints within the organization may hinder the development of needed resource centers to assist in the training process.

FAILURES RESULTING FROM CONFLICTS BETWEEN USER OBJECTIVES AND ORGANIZATIONAL PURPOSES OF THE NEW MIS

The productivity improvements offered by modern information systems, and thus the success of those systems, will be realized only to the extent that individual users use the systems effectively. In the preceding subsection, we stated that the resources provided by the organization for system use and training may not be adequate for effective system use, implying that the labor inputs are constrained to be less than l*. In this subsection, we assume that t and s are not constrained by the organization--at least not to levels such that l* cannot be attained--and focus on the decisions of individual users to supply labor inputs for system use. Recall that MIS labor input is a function of the time spent using the new MIS and the skill level of the user, as well as an index indicating the degree to which the use of the system by the individual is consistent with organizational goals. Further recall from an earlier section of this paper that the decision to provide labor inputs to the new MIS is assumed to be based on utility maximization of the individual.

For our purposes, we can describe the utility of an individual system user as a function of an array of factors that contribute positively or negatively to individual utility and which are also a function of the individual's inputs of labor to the new MIS. Note that we are not concerned here with how the individual allocates his or her resources among all possible demands for those resources. Rather, we are concerned only with the individual's allocation of resources to the use of the new information system within the individual's role as an employee of the organization implementing the new MIS. Being ignored are obvious tradeoffs that are made between the allocation of individual resources inside and outside the organizational environment.

The factors relevant to the individual's utility function may include income, leisure, job security, power, authority, job mobility, autonomy, work environment, and so forth. The individual user will provide labor inputs for system use based on his or her perceptions of how l will affect specific components of his or her utility function.

Let the utility function for individual MIS user i be given as

$$U_i = f[x_1(l_i), \ldots, x_n(l_i)] \ ,$$

where U is utility, x_j is the jth factor of utility for individual i that is a function of l_i, and n is the number of factors in the ith individual's utility function that is a function of l_i. The individual user of the new MIS selects his or her optimal labor inputs, l_i^*, according to the following maximization:

$$\text{Max } U_i = f[x_1(l_i), \ldots, x_n(l_i)] \text{ subject to } l_i \leq l_i^@ ,$$

where $l_i^@$ is the organizationally imposed limit, or physical limit, on individual i's labor input to the new MIS.

The above utility function can be restated in the following manner to better characterize the conflicts that may lead to system underutilization or misuse:

$$U_i = f \ x_1[PFC_i \cdot v_i(t_i,s_i),h_i(t_i,s_i)], \ldots, \ x_n[PFC_i \cdot v_i(t_i,s_i),h_i(t_i,s_i)] \ ,$$

or, stated more simply, by omitting the x's,

$$U_i = f[PFC_i \cdot v_i(t_i,s_i), \ h_i(t_i,s_i)] \ ,$$

where

$v_i(t_i,s_i)$ = the expected net increase in the organization's productivity as perceived by individual i that results from the use of the new system by individual i, given inputs of t_i and s_i in combination with some fixed MIS capital component k;

$h_i(t_i,s_i)$ = a function that is independent of $v_i(t_i,s_i)$ which relates the inputs of t_i and s_i by individual i to all changes in the x_j's that are not contained in $v_i(t_i,s_i)$;

PFC_i = an index ranging from -1 to +1 indicating the degree to which individual i complies with the organization's goals for the new MIS as perceived by individual i.

This reformulation of the individual's utility function requires more explanation. When selecting l_i^*, the individual system user can be assumed to base that decision on two broad objectives. The first is how the input of l_i will impact the organization's objectives and thereby indirectly impact one or more of the factors, x_j, in individual i's utility function. We can assume that the individual user has some beliefs about (1) the organization's overall objective and how the use of the new MIS can contribute to that objective [denoted here by $v_i(l)$] and (2) how the maximization of the organization's overall objective by the individual will benefit the individual user (given by $f[PFC \cdot v_i(1)]$). When PFC is equal to +1 and $h_i(t_i,s_i)$ is equal to 0, it is assumed that individual i uses the new MIS in a way that is totally consistent with the organization's goals for the system as perceived by individual i. When PFC is equal to -1 and $h_i(t_i,s_i)$ is equal to 0, it is assumed that individual i attempts to use the new MIS in a way that minimizes rather than maximizes the organization's goals for the new MIS, again as perceived by individual i. In other words, individual i attempts to sabotage the new system. When PFC is equal to 0, it is assumed that the goals of the organization with respect to the new MIS are irrelevant to individual i's utility function. In other words, individual i does not consider how his or her use of the new MIS will or will not contribute to organizational goals as he or she perceives those goals. The individual's selection of a particular PFC is discussed next.

The second broad objective of the individual user is denoted by $h_i(t_i,s_i)$. The individual user, by providing t and s, may increase or decrease utility by impacting some x_j's in ways that are independent of the goals of the organization. For example, skill obtained by individual i may contribute to the individual's job mobility outside the organization that is implementing the new MIS. Another example is the possible additional leisure time provided by the use of the new system. The individual user may base his or her decision about t and s not on how organizational productivity might be improved, but rather on how t and s impact the user's own personal goals for leisure within his or her role as an employee. When PFC is equal to 0, the input of labor by the individual is assumed to be based entirely on $h_i(t_i,s_i)$. The following paragraphs discuss the h function in more detail.

The preceding general formulation of the individual's objectives to use or not to use the new system allows us to discuss several potential problems that may lead to system underutilization or misuse. As stated earlier, the organization's goals for the new MIS are maximized when v(1) is maximized, denoted by 1*. We can assume that 1* can be disaggregated into labor inputs for each user. The individual's decision about l_i is, however, based on the maximization of U_i. The following conditions lead to the level of labor provided for system use by the individual user being less than or greater than the optimal level as perceived by the overall organization.

1. The v(1) perceived by the organization may not coincide with the $v_i(1)$ perceived by individual users. As discussed in a previous section, the new MIS can have several purposes, which will determine in part the perceived optimal inputs of labor. Recall that the new MIS may have one or more of three main purposes--(1) to increase information quantity, quality, and/or speed, thereby allowing the more efficient use of inputs to the organization's production process; (2) to decrease the costs of providing managerial information without necessarily increasing the level of information; and (3) to allow the redistribution of organizational authority and control. If the overall organization and the individual users adopt different perspectives

on the purposes of the system, the optimal labor inputs perceived by the users may be very different from what the larger organization believes to be optimal.

It is therefore important for upper management--which supposedly reflects the perspective of the overall organization and ultimately decides if the new MIS is a success or a failure--to communicate with individual users about the purposes of the new system. While a divergence between $v(1)$ and $v_i(1)$ does not necessarily imply system failure, it does imply that different groups within the organization perceive success and failure of the new system differently. In fact, an important managerial responsibility at the upper level of the organization is to decide which perspective is best for the organization. Top management can either attempt to impose what it believes to be an optimal labor component on users or assume that individual users have a better understanding of the optimal labor input and allow users to set their individual labor inputs. In the second case, it is important that individual users be involved in the selection and implementation of k. In either case, it is important to facilitate communication between the various groups so that each group understands, at least in general terms, the purposes and goals of the system.

Another related set of problems that may arise involves the perceived capabilities of the new system. Even if there is general agreement about the purposes of the new MIS, there may be significant mistrust of the capabilities of the new system, which could keep those purposes from being met.

A potentially serious problem arises if the individual perceives that productivity improvements are severely limited by the quality of the information obtained from the new system. Unlike the other two characteristics of information as we have defined it (i.e, quantity and speed), the quality of information from the new MIS is more difficult to convey to system users. Lucas and Turner concluded in their 1982 publication, "If managers believe they are unable to control the quality of information services provided within the firm, they are unlikely to rely on these services in meeting critical goals." Further, while the electronic flow and storage of information offers obvious possibilities for error reduction, there are potential reasons why information entered into the system may be inaccurate. Zakay (1982) suggested that reasons for data inaccuracies include "(1) nonentered information (i.e., information that is kept by users and not entered at all in the system); (2) biased information entered into the system; and (3) incorrect updating of the data base." According to Zakay, information may not be entered because of the individual's "fear of responsibility--the person whose function it is to enter data into the system is interested in hiding it in order to avoid responsibility in regard to the event reported." Zakay listed the "motivational tendency to ignore information which is contradictory to the existing belief system" as another reason for not entering the data. He also pointed out the fact that "The guardian of valuable information is powerful, and hence he will reluctantly share it with other users of the system." In addition, the "psychological stress" that results from "information overload" may cause the individual to only selectively collect and enter information. The system users may perceive that these quality problems exist and, therefore, may question the capabilities of the new MIS to meet its goals. Measures to maintain quality and communicate the findings of periodic quality checks are thus advisable.

2. Assume that $v(l)$ and $v_i(l)$ give equivalent l^*'s, $h_i(t_i,s_i)$ is equal to 0, and $l_i^@ \geq l_i^*$ for all i. A potential problem remains in translating increased organizational productivity into increased utility such that

$$dU/dl = dv/dl \quad .$$

Given our conceptualization of the problem, the translation of organizational productivity into individual utility is reflected in PFC_i. While the organization desires that PFC be equal to 1 for all i, the individual may comply only partially with organizational goals or may actually work against those goals, which is reflected by a negative PFC.

Recall that the $v_i(l)$ reflects how individual i perceives the inputs of t_i and s_i to contribute to the organization's productivity, while the PFC index indicates the degree to which the individual will comply with the organization's goals. As such, PFC is predominantly a function of the degree to which the organization can monitor and control the activities of the individual user.

If the individual user is to have an incentive to comply totally or partially with the organization's goals, there must be a mechanism whereby (1) the contribution of the inputs of t_i and s_i to the organization's productivity can be monitored by the organization and (2) the organization can reward or punish the individual accordingly by increasing or decreasing the x_j's (e.g., income, leisure, and authority). Supposedly, the greater the degree to which users can be monitored and rewarded or punished, the closer PFC becomes to +1. The less the organization can monitor and reward or punish the user, the closer PFC becomes to 0 and, in the case of the disgruntled user, may become negative and even approach -1 in the event of organizational sabotage.

The concept of the PFC in our conceptualization is closely related to what has been referred to as "shirking" in the economics literature. Shirking can be defined "as the act of seeking to avoid performance of contractual duty" (Staten and Umbeck 1982). The theory of shirking, which was developed to explain the relationship between employers and employees, suggests that contractual violations decrease as the costs of monitoring behavior decrease. If modern information systems reduce monitoring costs, shirking may be reduced, thus contributing to improvements in organizational productivity.

3. Assume that $v(l)$ and $v_i(l)$ give equivalent l^*'s, PFC_i is equal to 1, and $l_i^@ \geq l_i^*$ for all i. A problem remains in that the impacts of t_i and s_i on the x_j's through the $h(l)$ function may distort what might otherwise be an optimal allocation of labor to the use of the new MIS.

   As stated above, the $v_i(l)$ function indicates how the MIS users perceive the impacts of their use of the new system on organizational productivity. The PFC index indicates the degree to which the individual users consider their perceived organizational goals when selecting their inputs of labor to the new system. However, when the individual user makes a decision about t and s, that decision is obviously not solely based on how the use of the new system by the user will impact organizational goals, which are important to the individual user only to the extent that they lead indirectly to organizational rewards or punishments for the individual user.

   The motivations for using or not using the new MIS, outside of those that result from the fulfillment or unfulfillment of organizational goals, are incorporated into the $h(l)$ function. Some examples are in order. Consider the potential impacts of the new MIS on the individual's authority and control. It is entirely possible that the user may believe that the new MIS will allow the organization to be more productive by shifting authority and control away from that user to some other user. These productivity improvements are made possible by that user's forfeiture of authority and control and are reflected in the $v_i(l)$ function. However, while the user may believe that this purpose of the new system is good for the organization, it is likely that giving up authority and control may impose a direct negative impact on the individual's utility, which is reflected in the individual's $h(l)$ function.

   As a second example, consider the potential aversion of the user to new computer technologies. Again the individual may believe that the implementation and use of the new MIS will increase that individual's and the organization's productivity, which is reflected by $v_i(l)$. However, the individual may also have a severe dislike for computer technologies (incorporated in the $h(l)$ function) which is exacerbated by system training and use. The individual must therefore balance the direct negative impacts of using the new system against the potential indirect positive impacts that may be received from the organization for productivity improvements.

   Consider a third example--that of individual income. In this example, the individual expects the use of the new MIS to increase his or her level of productivity and also expects to be rewarded accordingly by the implementing organization. However, the user also believes that system training and use will increase his or her longer-term income prospects in that other organizations may be willing to outbid the user's current employer for his or her services. The point of this example is that the h(1) function may impact the individual's utility function in positive as well as negative ways and may lead to overuse as well as underutilization of the new system.

The components of the individual user's utility function, x_j, which are affected by h(1) are numerous and have been the focus of many, if not the majority of, studies addressing MIS success or failure. These components include income, leisure, job security, authority and control, job mobility, working environment, group autonomy, adversity to system training and computer technologies, job satisfaction, etc.

It is crucial that the implementer of a new MIS attempt to identify these x_j's. It is also crucial that the organization attempt to measure the degree to which the implementation and use of the new MIS affects these specific components of individual utility. In some cases, the impacts of h(1) may be so large that individual users will provide a level of labor input much greater than or much less than what the organization believes to be optimal.

The recognition and evaluation of the h(1) function can also be valuable in the organization's manipulation of the PFC. Assuming that the organization has the capability to measure individual gains in productivity from the use of the new MIS, the organization can devise incentive programs that take advantage of the h(1) function to reward individual users for effective system use and to help minimize the negative effects of system implementation and use.

CONCLUSIONS

The conceptual framework formulated in this report to describe how a modern computerized management information system may be used to increase organizational productivity and may ultimately succeed or fail in that purpose is based on numerous assumptions about the goals and constraints of the organization and individual users. This concluding section begins with a brief review of those assumptions and the resulting conceptual framework.

A basic assumption of the conceptual framework is that information is desired by individuals and organizations for the purpose of reducing uncertainty. In the case of the individual, additional information increases utility, and in the case of the organization (either a private firm or a public organization), the goal of additional information is to improve productivity.

It is then argued that information within the context of an information system can be discussed in terms of three key parameters: information quantity, information quality, and information speed. An increase in any one parameter while holding the other two constant constitutes additional information. From this conceptualization of information, we define a new information system as one that (1) allows additional information for organizational decision making to be a technical possibility and/or (2) reduces the per unit cost of managerial information for the organization.

The possible purposes of the new MIS are derived from this definition of a new information system. Three broad purposes that can lead to productivity improvements are possible. Additional information may be provided, possibly at a higher cost than with the old information system, with productivity improvements deriving from the more efficient use of inputs to the organization's production process. Alternatively, while no additional information may be provided by the new system, productivity improvements may be realized by simply lowering the total costs of management information. Finally, the new MIS, by providing additional information, may allow changes in organizational authority and control that can, but do not necessarily, lead to productivity improvements.

It is assumed that the organization selects a new MIS based on management's subjective assessment of the expected net productivity improvements to be derived from that system. It is assumed that the organization selects what is perceived to be the optimal capital components (i.e., the system's hardware and software components) and then attempts to provide an optimal level of labor or use of the system. It is further assumed that the capital components are difficult to alter in the short term and, thus, that the major focus of the organization in assuring success of the system is the input of labor. There is assumed to be some optimal level of labor input, which in combination with the given capital components leads to some maximum increase in organization productivity and thus total system success. There is also assumed to be some level of labor below which the new system leads to a lower level of productivity than that of the old system, thus constituting system failure. Labor inputs between those two extremes lead to partial system success or failure, depending on the perspective.

From this framework, several potential problems are then discussed that can lead to a partial or total failure of the new MIS. The first is a failure of the capital components. Obviously, if those components do not perform as expected or if the purposes of the new system change during the implementation phase such that adequate hardware and software become inadequate, the system will to some extent fail.

Second, system failure may result if the organization constrains the quantity of labor that the system users can provide. Such constraint may be in the form of limits on the time the organization effectively allows individuals to use the system. Alternatively, the problems may be manifested by inadequate system training.

The third and possibly most complex type of system failure is caused by differences in the goals for the new MIS as perceived by the organization and by the individual users. Three broad problems fit within this third type of system failure. The first occurs when (1) different parts of the organization perceive the purposes of the new MIS differently; or (2) there is agreement on the purposes of the new MIS, but there is internal disagreement about the capabilities of the new system to meet those purposes. In either case, there may be significant disagreement about how the system should be used. While this alone does not mean system failure, it does mean that the use of the system will not be consistent throughout the organization, which may in turn lead to failure or, alternatively, to the perception of failure.

The second potential problem within this third type of failure results directly from differences in the way the organization evaluates the use of the new system vs the way the individual user evaluates that use. It is assumed that the organization attempts to increase productivity and the individual attempts to increase utility. The individual's consideration of the organization's goals will be important, therefore, only to the extent that fulfilling the organization's goals in turn fulfills the individual's utility goals. In this report, we have termed the degree to which the user complies with the organization's goals as the Propensity for Compliance, or PFC. It is argued that compliance will be a function of the ability of the organization to measure the productivity gains achieved by the user in using the system and to appropriately reward or punish the user by impacting one or more of the components in the individuals's utility function. If productivity cannot be measured and/or rewards or punishments cannot be levied, the individual's decision about providing labor to use the new system will be independent of the organization's goals.

The third potential problem within this third type of failure involves the factors that determine the individual's use of the system outside of those factors affected by the realization of the organization's goals. The numerous individual factors within this set of factors (e.g., power, authority, control, job mobility) may be altered significantly by the implementation and use of the new system and may cause users to underutilize or misuse the new MIS even though they believe the use of the system could improve their and the overall organization's productivity.

The numerous studies of the success or failure of information systems--discussed briefly in the second section of this report--can be placed within the context of this general conceptual framework. In most cases, previous studies have focused on one of the broad problems discussed in this report which can lead to system failure; and those studies have given us significant insights into how particular problems can affect the success of an MIS. It is hoped that this report will help provide a broader framework within which those studies can be discussed and compared. By viewing previous work within a broader framework, new insights can hopefully be made about those studies and missing links in the assessment of MIS success or failure can be identified and ultimately addressed empirically.

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