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Identifying Relationships Among Factors in IS Implementation

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ABSTRACT

Information systems (IS) researchers find a large number of factors are related to the effectiveness of IS implementations; however, many researchers also lament the lack of theoretical relationships among the factors. In addition, recent studies of IS implementation produced conflicting results regarding the relative importance and manageability of IS implementation factors. To address these issues, we encourage researchers to think "out-of-the-box" as we propose a new way of viewing the traditional IS implementation factors. The nature of the relationships among the factors is analogous to Maslow's generally accepted theories of individual motivation in which certain factors are necessary but not sufficient conditions for given levels of achievement.

Keywords: IS implementation, diffusion of innovation, implementation factors

I. INTRODUCTION

Partly in response to the widespread failure of many IS implementation projects, IS researchers developed and empirically tested a number of factors related to the effective implementation of an information system [Fichman and Kemerer, 1993, Fichman and Kemerer, 1997, Leonard-Barton, 1987, Leonard-Barton and Deschamps, 1988, Zmud, 1982, Zmud, 1984]. In this context, a factor is defined as a technological, individual, or organizational force that is important to IS implementation effectiveness [Cooper and Zmud, 1990]. A number of proposed frameworks attempt to classify factors [Cooper and Zmud, 1990, Fichman, 1992, Kwon and Zmud, 1987]; however, many questions are still unanswered about relationships among the different factors in IS implementation research [Cooper and Zmud, 1990, Kwon and Zmud, 1987, Shaw, 1999]. For example, why do some implementations "fail," even though most of the critical success factors were controlled? Similarly, why are some implementations considered "successful" by some people while considered "failures" by others?

An additional problem for researchers is the lack of consensus on whether the majority of factors contributing to implementation effectiveness are organizational, technical, human, or a combination of issues. For example, how should one explain a series of results suggesting technical issues to be only of limited consequence in implementations [Griffith and Northcraft, 1993], other results showing an increasing emphasis on technical issues [Benamati, 1997, Benamati et al., 1997], and still other results showing differences in perceived and actual importance of technical issues [Shaw, 2001]? One possible explanation is that the majority of IS research studies focused solely on one class of problem, with little focus on the integration of organizational and technological issues. Such reasoning is especially relevant given the previously documented lack of investigation of relationships among multiple factors affecting IS implementation [Kwon and Zmud, 1987].

This paper proposes an integrative framework to reconcile previously-identified factors in IS implementation research. We integrate existing research streams and explain conflicting results in previous research through a number of propositions theorizing that some implementation factors are greater contributors to implementation success than others. Existing theories of IS implementation are generally valid and useful; however, as many researchers note, the theoretical base of IS literature largely ignores a number of relationships that likely exist among various IS implementation constructs [Cooper and Zmud, 1990, Fichman, 1992, Kwon and Zmud, 1987]. To address this shortcoming, we propose a new theoretical model, which uses ordinal relationships among the factors, and state a number of research propositions to formalize the relationships. Finally, we provide suggestions for empirical tests and discuss the appropriate context for the application of our ideas in practice.

II. FACTORS IN IS IMPLEMENTATION RESEARCH

A comprehensive research model for IS implementation studies was proposed by Kwon and Zmud [1987] to show the impact of five major contextual factors on the six stages of IS implementation. Table 1 illustrates this research model and shows prior research work investigating the topics specified by the model. The classification of existing research was accomplished by updating previous classifications [Cooper and Zmud, 1990, Fichman, 1992, Kwon and Zmud, 1987] with recent empirical and theoretical contributions.

Table 1. Model of IS Implementation

Stage	User	Organization	Task	Technology	Environment
Initiation		X		X	
Adoption	X	X	X	X	X
Adaptation	X	X			
Acceptance	X		X	X	X
Routinization	X	X		X	
Infusion			X	X	

Note: X indicates existing research coverage
Adapted from Cooper and Zmud [1990]

The five major implementation factors proposed by the model are shown across the top row of Table 1. Each has a specific meaning [Cooper and Zmud, 1990, Kwon and Zmud, 1987]:

- User – characteristics of the user community, such as resistance to change and education level,
- Organization – characteristics of the organization, such as centralization and organization structure,

- Task – characteristics of the task for which the innovation is used, such as task uncertainty and task variety,
- Technology – characteristics of the technology such as quality and complexity, and
- Environment – characteristics of the organizational environment, such as industry competitiveness and market forces.

Studies of these five basic implementation factors examine multiple perspectives, including:

- environmental [Lederer and Mendelow, 1990],
- cognitive [Griffith and Northcraft, 1993; Griffith and Northcraft, 1996],
- social [Sarker, 1995],
- institutional [King et al., 1994], and
- technological [Benamati, 1997, Benamati et al., 1997].

Curiously, the results from these empirical studies of implementation conflict in that some studies report cognitive and social problems as more severe than technological problems while others report more problems with technological issues. To compound the problem further, a recent study found differences in actual and perceived problems in IS implementations [Shaw, 1999]. In the study, 53% of users reported that the most troublesome issues during their implementation were caused by technological problems. In contrast, however, very few of the actual problems reported during these implementations were of a technical nature. Currently, no single theoretical view can consistently explain these results. Therefore, extensions to existing models of implementation are required.

III. RELATIONSHIPS AMONG FACTORS IN IS IMPLEMENTATION

Maslow's hierarchy of needs [Maslow, 1970] is a well-accepted theory suggesting that people are motivated by a desire to satisfy an increasingly complex hierarchy of needs. The theory posits that individuals must first satisfy basic needs such as physiological and security needs before attempting to satisfy higher-level needs such as esteem and self-actualization. The higher-level needs are generally more difficult to satisfy, yet they provide more fulfilling results in the cases in which they are satisfied. In addition, if an individual is not satisfied at basic levels of need, that individual will be unlikely to be concerned with higher levels of need. Although other researchers modified Maslow's theory since its original development, the fundamental principles remain intact. Thus a complete review of modifications to the theory is not presented here.

Using Maslow's hierarchy as an analogy, one can conceptualize the "needs" of an information system implementation as the five groups of factors specified in Table 1. That is, a successful implementation needs successful management of each of the groups of factors. Further, the relationships among those needs are given in the propositions of Maslow's hierarchy. They suggest that definite patterns to the nature and magnitude of problems occur during information systems implementations. Consequently, Maslow's hierarchy is useful in identifying previously unseen relationships among IT implementation factors. These relationships have interesting implications both for the practice and scholarship of information systems.

To illustrate further the parallels to Maslow's theory, Table 2 shows an IS-implementation-factor hierarchy in comparison to Maslow's hierarchy. The propositions of the IS-implementation-factor hierarchy suggest "levels" of factors (analogous to needs in Maslow's hierarchy) that an organization should address to have an effective implementation. For example, factors higher in the hierarchy are more difficult to manage (satisfy), but the rewards are greater if they are managed successfully.

The other propositions in IS implementation are also analogous to the other propositions of Maslow's theory. Since Maslow's hierarchy deals with individuals and motivation, some liberties must be taken to extend its principles to IS implementation, where the major constructs include organizations, people, and technologies. Still, the underlying ideas of both theories remain

similar, and Maslow's theory serves as an analogy which aids in understanding and applying the IS-implementation-factor hierarchy model.

Table 2, Comparison of the IS-Implementation-Factor Hierarchy and Maslow's Hierarchy of Needs

	IS-Implementation-Factor Hierarchy	Maslow's Hierarchy
Components	5. Environmental factors 4. Organizational factors 3. Task factors 2. User factors 1. Technological factors	5. Self-actualization needs 4. Esteem needs 3. Social needs 2. Security needs 1. Physiological needs
Major Propositions	• Some minimum threshold of effective implementation must be achieved at each level before benefits can be gained by managing factors at higher levels. • Effective management of factors higher up the hierarchy are more beneficial to the organization than factors at lower levels. • Factors at higher levels in the hierarchy are increasingly difficult to manage, control, and change. • Disruption associated with failure to manage low-level factors is perceived as more severe than disruption associated with higher-level factors.	• Individuals must first satisfy basic level needs such as physiological and security needs before attempting to satisfy higher-level needs such as esteem and self-actualization. • The higher-level needs are generally more difficult to satisfy yet they provide more fulfilling results in the cases in which they are satisfied. • If an individual is not satisfied at basic levels of need, that individual will be unlikely to be concerned with higher levels of need.

The technology level in Table 2 refers to the characteristics of the technology-related aspects of the IS. Technology issues to be addressed include purely technical issues such as compatibility and performance [Benamati et al., 1997, DeLone and McLean, 1992] as well as the interaction of other factors with technological issues. Technological factors are generally the easiest group of factors to control since, among other options, the organization might have the choice to purchase other technologies that might be more effective. Technological effectiveness means that the technology is working properly, but it does not ensure that anyone uses the technology nor that it results in any impact on the organization [Davis, 1989, Davis et al., 1989, DeLone and McLean, 1992, Goodhue and Thompson, 1995, Seddon, 1997]. Thus, technological effectiveness is the lowest form of implementation effectiveness. Technology forms the base component of the model, and it is represented by the lowest level in the hierarchy.

The user and task levels of the hierarchy focus on user and task issues in an information system implementation [DeSanctis and Poole, 1994, Goodhue and Thompson, 1995]. Examples of "pure" user issues include resistance to change, job tenure, and education [Cooper and Zmud, 1990]; however, the effect of any of these factors on an implementation depends upon the task to which they are applied and the technology involved. Effectiveness at the user level indicates that users use the new IS and are satisfied with it [DeLone and McLean, 1992, Seddon, 1997], and effectiveness at the task level means that the new technology impacts task performance successfully. Task factors are more difficult to manage than purely technological factors since

successful management of task factors requires not only successful technological management but also control of issues such as task uncertainty and task variety [Cooper and Zmud, 1990]. Consequently, the effects of task factors are more difficult to predict and therefore more difficult to control than technological factors.

The organizational level deals with organizational factors such as centralization, formalization, and specialization [Kwon and Zmud, 1987] and the intersections with the other groups of factors. Effectiveness at the organizational level is more beneficial than effectiveness at the task and user levels because the effects are more far-reaching. Instead of an individual task or set of tasks being affected, the entire organization will be affected positively if organizational factors are managed properly. Of course, the tradeoff is that organizational factors are more difficult to manage and control than task factors because additional complexity and uncertainty are introduced, since groups of users and tasks must be managed collectively.

The environmental level focuses on issues that are largely external to an organization. Previous IS research [Kwon and Zmud, 1987] argued that the environmental factors in implementations are in fact organizational environmental issues. At first glance, it might appear that this reasoning is in conflict with the proposed theory. However, the hierarchy is consistent with previous research because organizational environmental factors are examples of interactions between the environment and the organization. This interaction approach also adds to the previous research by allowing for the distinct evaluation of "pure" environmental factors. Environmental factors are the most difficult to control since they might be legal or market factors that are entirely out of the control of a particular firm. On the other hand, effectiveness at the environmental level is the ultimate goal of an information system [Clemons and Row, 1988, Hopper, 1990].

MANAGING FACTORS IN IS IMPLEMENTATION

Proposition 1: Some minimum threshold of effective implementation must be achieved at each level before benefits can be gained by managing factors at higher levels.

Empirical evidence indicates that organizations with technical and user problems do not succeed at higher levels of implementation [Benamati, 1997, Benamati et al., 1997, Shaw, 1999]. Note that completely effective implementation will likely never be achieved at a given level. To illustrate, consider a new software package that is introduced into an organization. If the software cannot use existing data to any extent, higher levels of implementation effectiveness cannot be achieved. On the other hand, if the software is not completely perfect, but works sufficiently, the organization can focus on higher order implementation issues. A similar concept was proposed by Broadbent et al. [1996] in the context of IS infrastructure where lower-level components such as hardware and software provide support for higher-level parts of the infrastructure. Similarly, structural theories of organizations suggest that users, tasks, and technologies indeed provide sources of structure for organizations [DeSanctis and Poole, 1994, Orlikowski, 1992]. Thus, the characteristics of the implementation of users, tasks, and technologies (for better or for worse) will to some extent impact the organizational and environmental aspects of the implementation. In summary, effective implementation at a technological level is a necessary but not sufficient condition for overall IS implementation effectiveness.

BENEFITS OF MANAGING IMPLEMENTATION FACTORS

Proposition 2: Effective management of factors higher up the hierarchy is more beneficial to the organization than factors at lower levels.

If the organization is successful at dealing with high-level factors such as environmental and organizational factors, the rewards are much greater than for successful management of low-level factors such as technology. For example, gaining competitive advantage through the successful implementation of an information system is generally a much more significant result than simply mastering the technology involved. This assertion is consistent with previous arguments in the IS literature that suggest environmental impact as the ultimate goal of an information system [Clemons and Row, 1988, Hopper, 1990, Wiseman and MacMillan, 1984]. Similarly, successfully implementing a technological innovation does not mean that it will create any impact on user, task, or firm performance [Davis, 1989, Davis et al., 1989, DeLone and McLean, 1992, Goodhue

and Thompson, 1995, Seddon, 1997]. In addition, a number of empirical studies designed to investigate organizational level impacts of IS implementation found that higher-level factors such as user and organizational factors influence organizational impacts more than technological factors [Gelderman, 1998, Grover et al., 1995, Lucas et al., 1988].

COMPLEXITY OF IMPLEMENTATION FACTORS

Proposition 3: Factors at higher levels in the hierarchy are increasingly difficult to manage, control, and change.

In contrast to the previous proposition, it is much more difficult for an organization to control and/or change environmental and organizational factors such as market forces and corporate culture than to control technical and user factors [Clemons and Row, 1988, Hopper, 1990, Porter and Millar, 1985]. Broadbent et al. (1996) propose that technological issues are the easiest to control due to their widespread use and replicability in the general marketplace. The proposition is also supported to some extent by evidence suggesting that organizational employees report that technical factors are much more well controlled in implementations than are user and organizational factors [Aydin and Rice, 1991].

PERCEPTIONS OF IMPLEMENTATION FACTORS

Proposition 4: Disruption associated with failure to manage low-level factors is perceived as more severe than disruption associated with higher- level factors.

Disruption is defined as a negative change associated with the impact of an IS implementation [Shaw, 1999]. Researchers argue that the majority of IS implementation problems result from human and organizational problems [Griffith and Northcraft, 1993, Griffith and Northcraft, 1996], yet some empirical studies found that most reported problems tend to be technically-oriented [Benamati, 1997, Benamati et al., 1997]. Thus, the fourth proposition suggests that the conflicting results can be explained as a difference in perception by study respondents. Support for the proposition is provided by previous studies that suggest a difference between the perceived and actual nature of IS implementation problems [Shaw, 2001] and by studies that show technical problems to be greater contributors to negative impacts of IS than other types of factors [Grover et al., 1995]. Technological and user problems tend to be noticed more than other factors, even if the other factors are in reality more prevalent. As an example, suppose that an organization introduces an information system with many technical problems such as system crashes and lost data. Even if organizational and environmental problems are present, individuals within the organization tend to remember the technical problems with greater frequency.

IV. DISCUSSION

Empirical testing of the IS-Implementation-Factor hierarchy is facilitated by the many existing research instruments that were used to capture and represent various factors. For example, existing instruments measure such factors as:

- user satisfaction [Bailey and Pearson, 1983, Baroudi et al., 1983, Doll and Torkzadeh, 1988, Doll et al., 1994, Montazemi, 1988],
- user acceptance [Davis, 1989, Davis et al., 1989, Dillon and Morris, 1996, Lee et al., 1995, Szajna, 1994], and
- task-technology fit [Goodhue and Thompson, 1995].

As an example of how these existing instruments can be used to investigate the hierarchy, consider Proposition 4, which theorizes a difference in the perception of problems versus actual problems in an implementation. An empirical test of Proposition 4 might be constructed in a manner similar to studies investigating the problems associated with changes in new technology [Benamati, 1997, Benamati et al., 1997]. These studies examined the implementation of various technologies at multiple organizations and determined sets of problems associated with the implementations. A study designed to test Proposition 4 might follow the same methodology but then might seek to compare actual numbers of problems and solutions with reported numbers of

problems and solutions. If Proposition 4 holds, then reported problems and solutions would tend to be located low in the hierarchy, while actual problems and solutions might be closer to the top levels.

APPLICATIONS OF THE HIERARCHY IN PRACTICE

For practitioners, the hierarchy aids in the implementation process by providing a mechanism for documenting and evaluating IS implementation problems and solutions. Assuming future research finds support for the propositions, organizations might find it useful to establish a balance [Rockart and Hofman, 1992] among the various implementation factors. If lower-level issues are ignored, they have the potential to hinder the implementation of the information system if they are not addressed at some minimum level of success. At the same time, organizations can strive to achieve goals at higher levels because the rewards are ultimately greater. In a specific implementation context, the hierarchy can also provide more significant and more detailed guidance to help ensure that an implementation is as smooth as possible. Thus, the propositions of the hierarchy are directly applicable to practitioners in three contexts:

1. planning for IS implementations before they begin,

2. managing ongoing IS implementation processes, and

3. analyzing completed implementations as a mechanism for future improvement.

As one example of the use of the hierarchy in practice, consider the first proposition, which suggests that organizations must manage lower-level (e.g., technical) factors successfully before they can manage higher-level (e.g., environmental) factors successfully. Managers often indicate frustration with their attempts to work with suppliers and other links in their supply chains. Many of them also report lower-level problems with their inter-organizational information systems due to outdated IT infrastructures and other, similar issues. In many cases, however, managers do not recognize the need for fixing these problems before attempting to deal with supplier connectivity issues. In retrospect, and according to the four propositions, it might be better for the managers first to fix the low-level problems associated with their systems and then to work out problems with suppliers.

Finally, there is an intriguing indirect application of the hierarchy that suggests refinement in the current practice of information systems development. Proposition 1 of the hierarchy suggests that users need to achieve satisfaction and acceptance of an information system at some minimum level before the collective organization can achieve satisfaction and acceptance of the information system. If this is the case, then it seems to be a reasonable conclusion that it would be useful to develop the system with this idea in mind. Thus, the hierarchy implies that bottom-up systems development might yield considerable advantages over top-down systems development in certain contexts because, by definition, lower-level system needs would be satisfied before higher-level system needs. Further, the theory suggests that if a system can be developed in such a way that it meets lower-level needs such as technological adequacy and user satisfaction, then it will be much more likely to meet the needs of the organization than a system that was designed to meet the organization's needs but is lacking technical adequacy or user satisfaction.

IMPLICATIONS FOR RESEARCH

If the four propositions of the hierarchy prove correct, they provide a number of suggestions for the future study of IS implementation in organizations. First, in any given study, because of the strong potential for confounding effects implementation researchers might wish to consider controlling for factors that are lower in the hierarchy than any primary factors in the researcher's empirical study. For example, a researcher studying organizational impacts of IS implementation could investigate the effect of user satisfaction on the organizational impact of the IS. Users who report low-levels of satisfaction might be dissatisfied because of technological implementation problems; however, the dissatisfaction might be manifested in higher-level problems if the effect of technology is not controlled.

Second, the hierarchy illustrates the importance of accounting for differences in perceived and actual phenomena caused by the relative importance of various IS implementation factors. According to the theorized relationships, problems at lower levels are generally perceived as more troublesome, even if the true cause of the problem is caused by a high-level factor, and such an effect might make it difficult for researchers to reach strong empirical conclusions about a high-level factor under study. Finally, the hierarchy reinforces previous views [e.g., Clemons and Row, 1988; DeLone and McLean, 1992] that researchers should focus on higher-level issues such as environmental and organizational impacts as the primary benefits of IS implementation.

From a theoretical perspective, future researchers might seek to investigate the generalizability of the hierarchy to other areas of information systems research. For example, the overall concept of an ordering of implementation factors appears to be consistent with other models in IS literature such as models of IS success and IS infrastructure [Broadbent et al., 1996, DeLone and McLean, 1992]. However, further theoretical development is needed to make strong conclusions regarding these similarities. In addition, theoretical exposition would be useful to examine the extent to which the propositions can be applied to more general phenomena such as the management of IT, without looking specifically at implementation issues. For example, further theoretical development could be initiated by applying the basic tenets of the hierarchy to areas such as IS planning and IS development.

LIMITATIONS

The major limitation of the theoretical relationships postulated in this paper is that they have not been empirically tested in a thorough and systematic manner, which would certainly be beyond the scope of one article and perhaps even beyond the scope of one empirical study. The empirical validity of the concept of an ordinal relationship among various types of IS implementation factors is one issue to be addressed in future studies, yet perhaps a more important research question deals with the relative ordering of specific factors that have been used in prior implementation research. An empirical study designed to test systematically the relative importance and manageability of the factors would provide a significant contribution to the further development of the theory. That is, researchers could carefully construct tests to determine where factors such as task/technology fit, user satisfaction, and system usage fit in the hierarchy.

V. CONCLUSION

The successful implementation of an information system can be attributed to a combination of many different types of factors. However, to be aware of the existence of such factors does not necessarily guarantee an effective implementation. When managers apply properly information about the factors and the relationships among them, IS implementation benefits from knowledge of the factors. Unfortunately, to date little theory tries to isolate meaningful relationships among the various factors in IS implementation.

Our research suggests that the major categories of factors associated with information systems implementation inherently are related by the nature of their impact on implementation. The factors are related by an ordinal relationship in which the successful management of factors that are closely tied to users, tasks, and technology is associated with different implications than the successful management of organizational and environmental factors. Specifically, the research suggests:

- User, task, and technology factors must be addressed first in an implementation, before organizational and environmental factors are addressed.
- Effective management of organizational and environmental factors is more beneficial to the organization than effective management of user, task, and technology factors.
- Effective management of organizational and environmental factors is more difficult than effective management of user, task, and technology factors.

- If they exist, user, task, and technology factors are perceived as the primary problems in an implementation, even if organizational and environmental problems are the root cause.

In summary, these ideas provide a reference model to evaluate, understand, and apply current and future knowledge about the factors that affect the implementation of an information system. While the use of the ordered factor approach does not guarantee effective implementations, it does represent a significant improvement over current knowledge of IS implementations, and thus it allows organizations and organizational researchers to make decisions that are more likely to result in effective IS implementations.

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