Towards a Theoretical Framework on Information Systems Development Success

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Towards a Theoretical Framework of Information Systems Development Success

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ABSTRACT

Information systems development (ISD) is a complicated process involving interconnected resources, objects, and outcomes. The importance of ISD has attracted long-term interests from both researchers and practitioners. Based on the input-process-output model, this paper developed a conceptual framework of ISD success through a systematic literature review. The paper argues that ISD is a comprehensive and interactive process among individuals, teams, and organization. These factors impact ISD process, and further affect ISD success.

Keywords

Information systems development (ISD), ISD success, ISD process, Individual factors, Team factors, Organizational factors, Input-process-output (I-P-O) model.

INTRODUCTION

Information systems development (ISD) is a complicated process involving interconnected resources, objects, and outcomes. An ISD project is always a risky and expensive undertaking. A better understanding of ISD is critical to both practitioners and researchers to ensure the success of ISD projects. An understanding of ISD will necessarily involve appreciating the (1) ISD process, (2) ISD product (outcome), (3) ISD participants, (4) ISD groups, (5) ISD organizational environment, and (6) interaction between these components. Past literature has investigated the factors impacting ISD success and ISD performance. However, because of the complex and interactive nature of ISD process, earlier research in this area only focuses on one or two perspectives each.

The purpose of this research is to develop an integrated and comprehensive conceptual framework of ISD success to guide future research. Based on the literature, the paper addressed the impact of three classes of variables—individual, team, and organization—on ISD process, and further on ISD success.

The paper is organized as follows. First a systematic literature review of factors impacting ISD performance is provided. Based on the syntheses of the literature review, the paper proposes a comprehensive and integrated conceptual framework of ISD success. Finally, we conclude with a discussion on future research directions.

RESEARCH MODEL DEVELOPMENT

This section first introduces the idea of input-process-output model. This is followed by a literature review on input factors (i.e., individual, group, and organizational factors), process (i.e. knowledge sharing, innovation, and system development methodology), and output factors (i.e. system usage and user satisfaction). A theoretical framework is then proposed based on the literature review.

Input-Process-Output Model

The classic input-process-output (I-P-O) model (Hackman 1987, McGrath 1984) provides a systematic way of viewing general working process. The I-P-O model presents the basic idea that inputs lead to processes and in turn lead to outcomes.
This theoretical framework has had a significant influence on recent empirical research, much of which either explicitly or implicitly invokes the I-P-O model.

Information systems development is a complex, adaptive, and dynamic process. To investigate the phenomenon in a systematic way, we followed the basic idea of the I-P-O model, and developed our ISD model by reviewing three sets of variables focusing on input, process, and output.

Input Variables

To get a comprehensive understanding, we focus our attention on research papers in the last twenty years and primarily on three top IS journals—MIS quarterly, Information Systems Research, and Journal of Management Information Systems. The following part elaborates three classes of variables—individual, team, and organization—on ISD process, and in turn, on ISD success.

Individual Factors

There are a number of individual characteristics that have been suggested in the literature that affect the success of the systems development process, such as personality, cognitive style, skill, user participation and involvement, problem solving style, experience, and expectation. The following discusses these factors.

Personality type theory is founded upon the work of Jung (1923). Several studies have used the Jungian typology (1968) to evaluate the personality types represented in project teams. For example, Kaiser and Bostrom (1982) examined the characteristics of individuals involved in systems development and suggested that these characteristics impact the way MIS designers perceived the organization, organizational members, and the functioning of a MIS system. Trimmer et al. (2002) examined the impact of personality diversity in ISD teams on different forms of conflict in the ISD team process. Bradley et al. (1997) highlighted the impact of personality type on team productivity and proposed a model that could be used to analyze the personality-type composition of an IS development team.

Cognitive styles have been derived from Jung’s (1923) theory of psychological types. Jung contended that people have distinctive differences in the way they gather and process data. Benbasat and Taylor (1978) explored the nature of cognitive styles and the effects of cognitive style differences on information system usage and design. Cognitive style perceptions were suggested as possible explanations for the communication barrier between system specialists and the users of information systems (Zmud, 1979).

White and Leifer (1986) examined how a mixture of technical and process skills impacts the success of the systems design process. Skill has been found to directly relate to increased team performance (Rash and Tosi, 1992). Boehm (1987) stressed the importance of selecting the most highly skilled people to work on a particular project, since the productivity difference between exceptional performers and average performers is significant. Guinan et al. (1998) suggested that group processes were important predictors of team performance in requirement determination. They also suggested that skill had a major influence on group processes and team performance. Thompson (1999) suggested that inadequate team member skill and means of performing work might lead to dysfunctions and poor team outcomes.

Two primary components of expectations are future time perspective and degree of uncertainty (Szajna and Scamell, 1993). User expectations for an information system is proposed as a set of beliefs held by the targeted users of an information system, which associated with the eventual performance of the IS and with their performance using the system (Szajna and Scamell, 1993). User expectations are positioned between pre-implementation factors (e.g., user involvement, management support, user training) and indicators of IS success (Sanders, 1984). Aronson and Carlsmit (1962) suggested that performance on a task is influenced by performance expectations. DeSanctis (1983) measured users’ expectancies and found them related to system use. In addition, Rushinek and Rushinek (1986) discovered that user expectations exhibited a strong association with overall satisfaction.

User expectations are concerned with systems benefit associated to user satisfaction (Hirschheim and Newman, 1988). An end-user attitude of high expectations for the system is positively correlated with high end-user satisfaction (Lawrence, M. and Low, 1993). Ginzberg (1981) found that the realism of user expectations: (1) was significantly correlated with user attitudes and usage of the information system and (2) explained the success or failure of an information system better than several other pre-implementation factors.
The dynamic nature of the systems development process can benefit from an awareness of user expectations. Assessing expectations at different stages of the process enables developers to diagnose and deal with problem areas before they become ingrained in the system (Szajna and Scannell, 1993).

The terms user participation and user involvement have been used interchangeably in the MIS literature. User participation has been widely touted by the MIS community as a means to improve user satisfaction within systems development. The importance of user participation in the systems development process has been widely recognized in the literature (Ives and Olson, 1984; Kappelman and McLean, 1991). Alter (1978), Gallagher (1974), Guthrie (1974), and Swanson (1974) found positive relationships between user involvement and system success.

**Team Factors**

Factors such as decision-making, resource, task and system complexity, conflict, and trust are found to influence ISD process, and in turn to affect ISD success.

The availability of resource has long been regarded as an important factor impacting ISD success (Wicson and Watson 2001, Ein-Dor and Segev 1978, Tait and Vessey 1988, McConnell 1996) and a critical element of the software development project (Sommerville, 1996; Pressman, 1997). Resources typically refer to people, money, material, and time that are required to successfully complete an IS project.

Ein-Dor and Segev (1978) identified two major types of resource constraints to ISD — internal resources and external resources. The researchers argue that constraints of resources contribute to the failure of ISD, while the availability of resources lead to a better chance of overcoming organizational obstacles and achieving organizational commitment (Beath 1991; Tait and Vessey 1988).

**Decision-making** is conducted throughout the whole process of ISD. At the beginning of a project, team leader should establish the system’s goal. During the development process, whether to continue or abandon a troubled project is another dilemma. These decisions are no doubt closely related to the failure or success of an ISD project.

Abdel-Hamid et al. (1999) studied the association between goals and project actions. Through a role-playing project simulation game (in which participants were asked to play as a team leader with different goal settings), the researchers investigated the impact of different goal settings (i.e., cost/schedule and quality/schedule in this case) on decision-making behavior and resource allocation, and further, on project performance. The findings suggest that with a given project goal, team managers do make planning and resource allocations to meet such a goal. These planning and resource allocations affect project performance.

Other researchers (Keil et al. 2000, Keil, 1995) address the decision-making during the procedure of systems development. They investigated factors influencing manager’s decision on the escalation of a project. These decisions are closely related to the project performance, and further, success or failure of that ISD project.

According to Daft et al. (1987), complexity arises from ambiguity and lack of structure in the tasks and sub-tasks involved. Two types of complexity are important in systems development—task complexity and systems complexity (Mckeen et al., 1994). The increase of the project complexity decreases the assurance of project goals (Naumann et al. 1980). With a complex project, ambiguity and uncertainty may arise during the specification, design, and implement of the system, thus increase the likelihood of system failure.

**Organization Factors**

The organizational implications of ISD are usually so extensive that it is natural to view development procedure from a wider context of organizational change and organizational design (Sillince and Mouakket, 1997). From the perspective of an organization, therefore, an information system could be regarded as a form of social organization and its success depends on whether it facilitates or impedes organizational evolvement and adaptation (Sillince and Mouakket, 1997).

Several factors play important roles during the process of adopting ISD into an organization, and further impacting the ISD success. These factors include IS strategic planning, top management support, IT governance style, organization learning environment, and other factors.

**IS strategy** refers to a comprehensive set of plans of system objectives, constraints, and design strategies (King and Teo, 1997). IS/IT strategic planning (Brancheau and Wetherbe, 1987) as well as the alignment between IT strategy and organization objectives has long been regarded as top issues in ISD success (Reich and Benbasat, 1996; Computerworld,
Although papers focus on varied perspective of IS planning, most of them accepted that the IS planning is an essential factor impacting those ISD success.

**Top management support** refers to the widespread sponsorship of a project such as resource providence and resistance prevention. Top management support is well accepted as an important issue in ISD. Empirical studies highlight the importance of top management support in assuring ISD (such as decision support systems) success (Etton et al. 2000; Sauer, 1993; Guimares et al. 1992; Igharia et al. 1997). Management support can motivate people to adapt to organizational changes accompanying with the ISD and can prevent political resistance as well as encourage employee participation (Markus 1988). People have the tendency to accept an information system that is according to the management expectation (Karahanna et al. 1999).

**IT governance** style refers to the pattern of IT authority in organization, which consists of IT infrastructure, IT usage, and project management (Sambamurthy and Zmud, 1999). Sambamurthy and Zmud (1999) empirically studied the factors impacting IT governance modes. The results of the case study support that the contingency forces (e.g., reinforcing, conflicting and dominating) influence IT governance. The pattern of IT governance represents the IT-related authority and resource arrangement of an organization. An appropriate IT governance style, therefore, is closely related to the systems development success. Because **organizational knowledge** is complex and hard to mimic, organizational knowledge resource may produce long-term competitive advantage (Alavi and Leidner, 2001). Information systems researchers suggest that organization knowledge is captured through organization technology, structure, and routine (Leonard and Sensiper, 1998). The relationship between the information systems and organizational knowledge is interactive. On one hand, information systems play an important role in the organizational knowledge process, including creation, storage/retrieval, transfer, and application (Holzner and Marx 1979; Pentland 1995). On the other hand, understanding organization environment and utilizing organizational knowledge for information systems development are regarded as pre-requisites for ISD success. Other factors, such as organization characteristics (such as size, revenue, and industry type), organization infrastructure and process (such as administrative structure, processes, and skills), politics, and culture (Silliance and Mouakket, 1997) are also found to be important during information systems development. These factors could be regarded as organizational environmental components influencing ISD success.

**Process**

**Learning/Knowledge sharing**

Argyris and Schon (1994) divided learning into single-loop and double-loop learning. Senge (1990) distinguished between adaptive learning (learning to cope) and generative learning (learning to create). March (1991) characterized learning as the exploitation of old certainties and the exploration of new possibilities. When people are forced to reflect on how they undertake their work in order to explain how to automate it, they have the opportunity to modify their understanding of how their work processes can be improved (Davenport and Short, 1990). Systems employing traditional development methodologies are typically developed, used, and refined as their developers and users learn more about them and about the use to which they will be put. In theory, this iterative process enables users to learn about what they need and enables developers to build and modify systems according to users' changing requirements (Stein and Vandenbosch, 1996).

Salawa (1987) studied the organizational learning interaction process in ISD. The result shows that the information generated from communications between users and analysts forms the basis for ISD and is therefore a major determinant of success. Users and analysts are more likely to uncover errors when they continue to pursue discussion on a topic until it is fully understood, rather than frequently starting new topics without resolving the previous topic. Stein and Vandenbosch (1996) examined the opportunities for and obstacles to organizational learning during the life cycle of advanced information systems.

**Innovation/Creativity**

A process innovation is defined as any innovation that changes the way a job is performed (Damanpour, 1991). Contingency studies generally indicate that a fit between various characteristics and the software process innovation increases system success (Hardgrave and Johnson, 2003). Nilakanta and Scamell (1990) examined the process of diffusion of innovations in the context of data base system development. Fagon (2004) investigated the role of creative style and climate in work
creativity on teams striving to develop innovative IT designs. Many observers of the data processing industry feel that the effectiveness of application systems has not increased as rapidly as that of the hardware on which they are implemented. The need for more creative approaches to ISD is proposed. Seiler et al. (1983) examined those pressures on design personnel which stifle creativity, and provided suggestions for overcoming those pressures. Couger (1990) discussed the widespread applicability of the creative theory to information system design. He discussed the classification of the theories of creativity, phases of the process of creativity, and various techniques to facilitate the creativity process. He suggested several ways to ensure creativity in system design. Couger (2000) adapted a creativity model from organization theory and used it to develop propositions regarding organizational characteristics that could foster IT development creativity in organizations. Managing IT development creativity is a complex process, requiring a good grasp of characteristics that can affect creativity, and an ability to effectively manipulate those characteristics. Couger’s model (2000) helps managers and researchers to identify important variables and relationships in the IT creativity process. In addition, the model facilitates managers to plan and execute logical design process based on the IT requirements.

**System Development Methodology**

At the general level, a methodology is regarded as a recommended series of steps and procedures to be followed in the course of developing an information system. Research on ISD methodologies is generally restricted to the creation or elaboration of methodologies. Westrup (1993) proposed that a fruitful area of research, which will provide insights into the effectiveness of ISD methodologies, must centre on the observation of the practice of systems developers, users, and managers, and the study of methodologies in use.

**Paradigm**

Paradigmatic assumptions can be divided into: ontology (what is assumed to be the nature of IS), epistemology (what is human knowledge and how it can be acquired), research methodology (what are the preferred research methods for developing and continuously improving the ISD approaches and what are the scientific and justified means of gathering evidence), and ethics (what are the values that ought to guide IS research) (Iivari, Hirschheim, and Klein, 1998).

**Model**

The model is the basis of the methodology’s view of the world. It works at a number of levels: a means of communication, a way of capturing the essence of a problem or a design, and a representation which provides insight into the problem or area of concern.

It has been stated that a model is a form of abstraction. Abstraction can be viewed as any simplification of systems and objects at any level, the conceptual, logical, and physical.

**Technique and tool**

In Iivari et al. (1998)’s article, an ISD method was defined as a codified set of goal-oriented 'procedures' which are intended to guide the work and cooperation of the various parties (stakeholders) involved in the building of an information systems application. Typically, these procedures are supported by a set of preferred techniques and tools, and guiding principles. A technique consists of a well-defined sequence of elementary operations that more or less guarantee the achievement of certain outcomes if executed correctly.

**Output Variables**

There are many ways to view ISD success. ISD success is a multi-facet construct (Wixom and Warson, 2001). The choice of ISD success measurement is based on the research purposes and the phenomena under investigation (DeLone and McLean, 1992).

The following table summarizes measurements based on various perspectives.

Based on the table, we argue that ISD success could be typically measured by systems usage and user perceived satisfaction. The former is the behavior of using a system, while the latter is the attitude towards a specific system.
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<td>• Data quality</td>
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<td>• Perceived net benefits</td>
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Table 1. Summary of ISD success measurement

THEORETICAL FRAMEWORK OF INFORMATION SYSTEMS DEVELOPMENT SUCCESS

Based on the syntheses of literature review, we present a theoretical framework of ISD success, which summarizes the ideas, factors, and relationships discussed above.
The framework (as shown in figure 1) addresses three classes of variables—individual, team, and organization, and their impact on ISD process, and in turn, ISD success. These three classes of input variables form an interactive context for information systems development.

CONCLUSION

Based on the literature review, this paper developed a conceptual framework of ISD success. The framework synthesizes individual, team, and organizational factors. It enhances the understanding of ISD success and provides guidelines for future empirical study. Although the proposed model may be limited to existing literature and research, it is our contention that the major factors in ISD success have been taken into account.

With this framework, researchers and practitioners can focus their research interests on specific factors (components) impacting ISD process and ISD success. Future research can examine and test the various variables in the model. Future research can also extend the model presented in this paper by demonstrating how individual, team, and organizational factors interact in the process. In addition, the model can be extended to study the relationships between process success and system success.
REFERENCES