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ABSTRACT

Information systems (IS) effectiveness is a multidimensional construct which can be influenced by individual characteristics, individual beliefs about the system and institutional factors. Prior researchers have examined the effects of a wide range of factors on IS adoption and successful IS implementation. However, these factors are separated in IS adoption and post-adoption research areas and isolated from each other in affecting IS effectiveness. This study demonstrates the relevance of these factors and organizational factors moderating the effects among the individual characteristics, beliefs about the system and IS effectiveness. The purpose of this study is to give a comprehensive picture of IS effectiveness using the multilevel analysis.

Keywords

Information systems, IS success, IS effectiveness, information systems evaluation, IS assessment, multilevel analysis

INTRODUCTION

Information technology (IT) is pervasive in modern organizations and seen as a fundamental method of gaining strategic and competitive advantage. It is widely acknowledged that the successful implementation of information systems remains a managerial challenge. Many new information systems are either rejected by end users or under-utilized (Markus & Keil, 1994). Although senior managers might make primary adoption decisions related to IS, it is the individuals within the firms who are the ultimate users and consumers of the systems. Thus, IS effectiveness is contingent on the extent to which users use IT in their workplace, in turn, contribute to organizational performance. Not surprisingly, the determinants of individual acceptance and use of IS in organizations are significant for IS effectiveness (Lewis, Agarwal & Sambamurthy, 2003).

A number of factors have been identified to contribute to the IS usage and implementation success, such as individual characteristics, individual beliefs about the system, task-technology fit, and institutional factors (Guimaraes & Igbaria, 1997). Moreover, prior research has tested the influence of numerous individual factors on technology acceptance outcomes (Agarwal & Prasad, 1999; Zmud, 1979). Perceptions about the characteristics of technology are not invariant across individuals (Davis, 1989; Lewis et al., 2003). Such beliefs are internal and psychological constructs which have a profound impact on subsequent individual behavior toward IS (Agarwal, Sambamurthy & Stair, 2000). The determinants of beliefs are external variables that may be controlled through appropriate managerial interventions. Task-technology fit, a construct related to the use-productivity, plays the same role with constructs, such as usefulness, relative advantage and job fit. IS researchers have also identified institutional factors as critical factors in successful implementation of IS (Sharma & Yetton, 2003). A key proposition of this study is that the institutional factors affect users' ability and motivation to successfully adopt and use IS, which are the prerequisites for IS effectiveness. Top management support, industry type, organizational size, structure and culture have been identified as important institutional factors (Damanpour, 1991; Linton, 2002).

Previous research has identified individual characteristics and beliefs about IS that affect system adoption. IS adoption is the first step toward realizing IS success, while system continued use is more important to its eventual success (Bhattacherjee, 2001; Karahanna, Straub & Chervany, 1999). Individual characteristics are intrinsic nature which determine system adoption and continued use. Favorable perceptions of the system are necessary for initial acceptance (Davis, 1989; Venkatesh, 2000), which of course is essential for adoption and continued use. It is reasonable to expect that these antecedents in IS adoption stage would affect IS continuance, and contribute to IS effectiveness. However, these factors are separated in different research areas (e.g., IS innovation, adoption, implementation and success) and isolated from each other in affecting IS usage and implementation. The causal relationships among these factors are still missing. Putting individuals into institutional context and trying to find their interrelationships would be a good start in IS effectiveness research area. In order to identify the potential moderators, we draw upon the research on the role of the institutional context in the IS

implementation. In addition, this paper tries to verify whether antecedents in the adoption stage are affecting IS effectiveness in the implementation stage.

This study is organized around a model that is believed to portray the effects of individual characteristics, beliefs about IS use and the organizational factors on IS effectiveness and organizational factors as moderating effect on the links among individual characteristics, their beliefs and IS effectiveness. On the basis of reviewing the related literature, we propose a theoretical model of IS effectiveness which is associated with several research hypotheses. The following section describes the methodology used to test the hypotheses. The final section summarizes the contributions and limitations.

THEORETICAL FOUNDATIONS AND RESEARCH HYPOTHESES

Theoretical Foundations:

IS effectiveness can be assessed from use, user satisfaction, individual impact and organizational impact. IS effectiveness is a multidimensional and multilevel construct. Our focus is on the individual level. IS effectiveness is the extent to which a given IS affects the users' performance (DeLone & McLean, 1992). This definition suggests that users and information systems are the intrinsic factors, which are the most important factors, in the process of affecting IS effectiveness. The users' characteristics in IT dimension would be the important antecedents to IS usage, satisfaction and effectiveness. In addition, system characteristics are also critical to IS effectiveness. Perceptions from the users' perspective are likely to be critical in assessing IS effectiveness. Usefulness and Ease of Use are important constructs to delineate their perceptions on IS (Davis, 1989). In the organizational context, system usage is mandatory so users' perceptions and behaviors are subject to the influences of organizational factors. Top management support and business structure are likely to be the salient organizational factors. Being extrinsic factors, they affect the IS effectiveness directly and moderate the relationships among intrinsic factors and IS effectiveness. Figure 1 illustrates key constructs and relationships in the integrated IS effectiveness model.

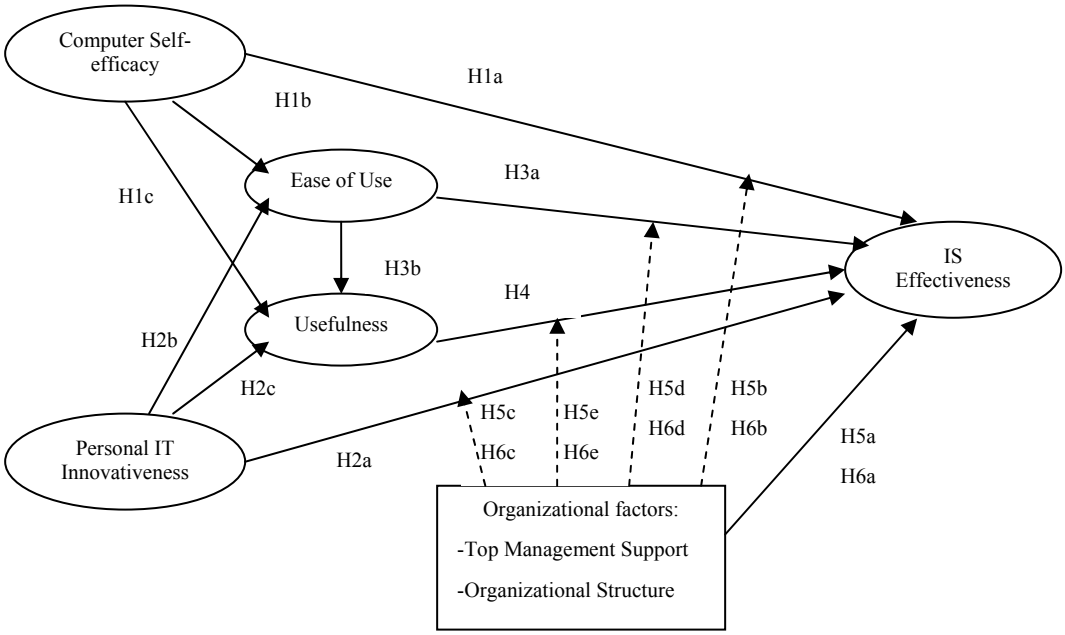

Figure 1 Research Model

Research Hypotheses:

The foundational hypothesis of this study is that users' characteristics are important for their perceptions of specific information systems and IS effectiveness. In the workplace, organizational factors which influence individual behavior

toward technology play an important role (Lewis et al., 2003). The key users' characteristics and their perceptions of the IS are selected for generating the hypotheses.

Computer Self-efficacy and Personal IT Innovativeness:

The most proximate influence on an individual cognitive interpretations and performance of information systems is coming from individual-related factors, among which computer self-efficacy and personal IT innovativeness are two constructs that have received consistent support as important predictors.

Self-efficacy is defined as beliefs about one's ability to perform a specific behavior (Bandura, 1977). It is viewed as an important antecedent to IS usage and success to the extent that it fosters both the adoption of new behavior and its maintenance. The inclusion of computer self-efficacy is critical to the recognition that adoption and implementation of IS is not just about convincing people of the benefits to be derived from a technology, but also requiring requisite skills and confidence one should have. IS innovations are often based on complex technologies that pose a high knowledge burden and are difficult for end users to grasp. In such cases, the ability of end users to learn and use technologies effectively is often critical to successful implementation.

IS researchers have found that self-efficacy tailored to an IT context is an important determinant of a variety of user perception of technologies. Compeau and Higgins (1995) argued that computer self-efficacy influences outcome expectation, which includes the items in perceived usefulness. Davis (1989) and Agarwal et al. (2000) posited and found empirical support for a significant relationship between general computer self-efficacy and perceptions about the ease of use of a specific technology. End users will resist IS when they perceive learning barriers to be high. The above discussions lead to the following research hypotheses:

H1a: Computer self-efficacy is positively associated with IS effectiveness.

H1b: Computer self-efficacy is positively associated with Ease of Use.

H1c: Computer self-efficacy is positively associated with Usefulness.

Personal Innovativeness represents the degree to which an individual is willing to try out any new IT (Agarwal and Prasad, 1998). It is treated as an individual propensity that is associated with more positive beliefs about technology use. Individuals are identified as innovative if they are early to adopt an innovation. Such individuals can then serve as key change agents and opinion leaders to facilitate further diffusion of a new technology (Rogers, 1995). Personal innovativeness in IT could potentially affect how individuals respond to IS innovations, and then individual behavior toward IS innovations. It is reasonable to expect that they are more likely to achieve implementation success compared with less innovative persons.

Personal innovativeness in IT epitomizes the risk-taking propensity that exists in innovators. Rogers (1995) argues that innovators are able to cope with higher levels of uncertainty. Therefore, it is reasonable to expect that individuals with higher personal innovativeness in IT will develop more positive perceptions about the IS innovation. In Technology Acceptance model, usefulness and ease of use are antecedents of attitude, intention and actual usage toward IT. The reason why different users would have different perceptions of the same IT is individual differences. Personal innovativeness in IT which is an important individual difference variable would help us to further understand how perceptions are formed and the subsequent role they play in the process of IS implementation (Agarwal and Prasad, 1998). Innovators in IT would be more likely to embrace IS innovation, and it is reasonable to believe that they are more likely to try to know about the system and feel the usefulness and ease of use of the system compared with less innovative persons. Hence, it is appropriate to postulate the following hypotheses:

H2a: Personal innovativeness in IT is positively associated with IS effectiveness.

H2b: Personal innovativeness in IT is positively associated with Ease of Use.

H2c: Personal innovativeness in IT is positively associated with Usefulness.

Ease of Use and Usefulness:

Beliefs about IS represent the cognitive structures that an individual develops after collecting, processing, and synthesizing information about the specific IS, and incorporates individual assessments of various outcomes associated with system usage. Individual beliefs about IS usage have been shown to have a profound impact on subsequent behavior toward IS. Ease of use is a construct tied to individual assessment of the effort involved in the process of using the system (Davis, 1989). A vast body of research in behavioral decision making and IS demonstrate that individuals attempt to minimize effort in their behaviors, thus supporting a relationship between perceived ease of use and usage behavior.

Ease of use is the opposite of perceived complexity. Organizations that perceive their IS to be a complex business solution will tend to diffuse it slowly and in limited capacity, thus not realizing its full benefits. So will the individual users. It is also suggested that the perceived complexity of IS leads to resistance due to lack of skills and knowledge (Rogers, 1995). This resistance to new technologies leads to lower satisfaction and system performance.

Usefulness will be influenced by ease of use because other things being equal, the easier the system is to use, the more useful it can be (Venkatesh, 2000). Davis (1989) found that the perceived usefulness was significantly correlated with self-reported measures of system use, whereas perceived ease of use was not. This led Davis (1989) to conclude that perceived ease of use "may be an antecedent to usefulness, rather than a parallel, direct determinant of usage" (p.319).

Enhanced IS effectiveness is instrumental in achieving various rewards that are extrinsic to the task context, such as promotions or monetary gains (Vroom, 1964). IS usage is often viewed as the means to that end. The process of information technology adoption and use is critical to deriving the benefits of information technology. That is why IT usage is a key dependent variable in IS research (DeLone & McLean, 1992). While initial acceptance of IS is an important first step toward realizing IS success, long-term viability of an IS and its eventual success depend more on its continued use (Bhattacherjee, 2001). Moore and Benbasat (1996) have found perceived usefulness and ease of use to be most influential for continued use decisions. In a study of IS post-adoption beliefs, Karahanna et al. (1999) have also found the important role of perceived usefulness in adopting and continuing to use IS. Based on these discussions, the following hypotheses are postulated:

H3a: Ease of use is positively associated with IS effectiveness.

H3b: Ease of use is positively associated with usefulness.

H4: Usefulness is positively associated with IS effectiveness.

Top Management Support:

Management support is considered to be a critical factor in the successful implementation of IS innovations (Purvis, Sambamurthy & Zmud, 2001). Management support is critical because the IS implementation is resource intensive. Substantial materials and managerial resources are required not only to develop IS applications and infrastructures, but also to support end users during implementation. In addition, support and supervision of end users during implementation also contribute to implementation success. Managers need to work closely with end users to mandate, negotiate, persuade, motivate, and support them in adopting and using IS. Management support is also considered critical for reconceptualizing work process and for changing existing routines and processes that are critical for successful implementation.

IS innovation often redesigns business processes and patterns of work flow. New horizontal and vertical coordination mechanisms required to ensure high levels of performance are accompanied by changes to existing organizational boundaries. Such changes are constrained by their effect on existing power structures (Tornatzky and Fleischer, 1990). According to Laughlin (1999), the first step of business in an ERP initiative is to gain full commitment from senior executives. Additionally, top management support is needed to send clear signals to various parts of the organization about the important of specific IS. Therefore, we get the following hypothesis:

H5a: Top management support is positively associated with IS effectiveness.

Top management interventions, such as authorizing end-user training and the development of end-user resource materials, can encourage end users to learn and overcome barriers resulted from lacking information about the system. End-users' training is very helpful for enhancing individual IT skills and expertise, which means enhancement of their computer self-efficacy.

Personal innovativeness in IT is conceptualized as an individual trait reflecting a willingness to try out any new technology. Innovators are "active information seekers about new ideas" (Rogers, 1995, p. 22). Kirton (1976) notes that innovation, by its very nature, is associated with greater risk, uncertainty, and imprecision. Because individuals with high personal innovativeness would have high risk-taking propensity, they are likely to develop more positive beliefs toward the use of IS innovation compared with less innovative persons (Agarwal and Prasad, 1998). Top management support can give them a signal of the importance of the specific IS. These management actions legitimize IS innovations and signal management commitment to successful implementation. Meanwhile, top management support can convince end users to expend the effort required to adopt and use the IS innovations. Because of the decrease of uncertainty, individuals with personal innovativeness in IT would be more active in using the specific system; therefore they are more likely to get the better performance from using IS. Based on the above discussion, we posit the following hypotheses:

H5b: Top management support can enhance the effects of computer self-efficacy on IS effectiveness.

H5c: Top management support can enhance the effects of personal innovativeness in IT on IS effectiveness.

IS innovations are often rejected by end users when they do not perceive the benefits from adoption to outweigh the costs involved (Purvis et al., 2001). Expected improvement in performance is a key factor in user's evaluation of the perceived benefits of IS innovations (Davis, 1989; Rogers, 1995). Perceived usefulness is the significant variable in affecting IS continuance (Karahanna et al., 1999) and IS effectiveness. IS adoption and IS continuance perform in the workplace, so they are circumscribed by institutional contexts. Organizational performance control systems reward specific behaviors and the achievement of specific outcomes (Kirsch, 1997). This would give the users a signal that organizations favoring the IS using, thus users with perceived usefulness belief would be more confident in using the system and achieving high performance.

Ease of use represents good system quality. IS with ease of use leads to less resistance from users and contributes to IS adoption and IS continuance. Similar to usefulness, top management support would make users more confident in using IS because their interests and incentives are aligned with the organizational objective. It is more likely to expect that users will get good performance. Therefore, we propose the following hypotheses:

H5d: Top management support can enhance the effects of ease of use on IS effectiveness.

H5e: Top management support can enhance the effects of usefulness on IS effectiveness.

Organizational Structure:

Damanpour (1991) suggests that the success of an implementation process is a function of organizational characteristics. Being an important organizational characteristic, organizational structures are often classified into two distinct categories: centralization and decentralization. Although organizational structures have been widely studied in their relationship with the introduction of a new technology, their effects on the IS effectiveness have not reached an agreement. Some researchers found that centralization was negatively associated with IT innovation and usage (Cohn and Turyn, 1980; Damanpour, 1991), while some positive relationships have also been stated (Marcus, 1980). IS implementation is considered to be an organization-wide event. Its implementation needs active participation at all levels, from the senior managers to end-users. The concentration of decision-making authority prevents innovative solutions, while the dispersion of power is necessary for IS implementation (Thompson, 1965). Decentralization would facilitate IS diffusion by increasing organizational members' awareness, commitment, and involvement (Damanpour, 1991). It is reasonable to expect that IS effectiveness may be related to the degree of decentralization of the organization implementing the IS. Therefore, the following hypothesis is proposed:

H6a: Organizations that are decentralized will be more likely associated with IS effectiveness than those that are centralized.

Computer self-efficacy and personal innovativeness in IT would be likely to lead to IS adoption and IT continuance (Lewis et al., 2003; Bhattacherjee, 2001). Thus, these two variables are expected to be intrinsic driver to IS effectiveness. Organizational structure as an important extrinsic factor would be instrumental in the effects of individual characteristics on IS effectiveness. Decentralized organizations would contribute to increasing organizational members' awareness, commitment and involvement so it would be more likely to provide an internal climate conducive to IS adoption and implementation for the individuals with high computer self-efficacy and personal innovativeness in IT (Damanpour, 1991). Therefore, we propose the following hypotheses:

H6b: Organizations that are decentralized can enhance the effects of computer self-efficacy on IS effectiveness.

H6c: Organizations that are decentralized can enhance the effects of personal innovativeness in IT on IS effectiveness.

Prior studies argue that organizational structure can help or hinder the implementation and success of specific information systems (Bingi et al., 1999). When organizational participants perceive specific IS as being valuable to their jobs and easy to use, they tend to accept and implement it, and thus are more likely to get IS effectiveness. Decentralized organizations can easily get the support and involvement from top to down throughout the organization so IS adoption and implementation would get less resistance and barriers compared with the centralized organizations. At the same time, management support will also release a signal to the users that IS innovation is aligned with their organizational objective. Therefore, in this organizational context, the users perceived the system as usefulness and ease of use would be more likely to use the IS and get better performance. Therefore, we posit:

H6d: Organizations that are decentralized can enhance the effects of ease of use on IS effectiveness.

H6e: Organizations that are decentralized can enhance the effects of usefulness on IS effectiveness.

Control Variables:

Firm size, industry type and elapsed time are employed as control variables in this study.

RESEARCH METHODOLOGY

Model Operationalization

The research model has seven constructs. All of them can be operationalized by utilizing the existing measures. The dependent variable is IS effectiveness which is indicated by system usage, user satisfaction and individual net benefit (DeLone and McLean, 1992). From the variety of self-reported measures of system usage, the method used by Kim and Lee (1986) is preferred due to its inclusion of the degree of voluntariness. This is due to the belief that if IS use is mandatory, system usage may not be an appropriate measure of IS effectiveness. This measurement includes two items: frequency of use and voluntariness of use. Each measure is assessed via a single seven-point likert-type scale item; the scale associated with frequency is anchored by 1=much less frequent use and 7=very frequent use, while the scale associated with voluntariness is anchored by 1=completely mandatory use and 7=completely voluntary use. User satisfaction is measured via a single seven-point likert-type scale item "All in all, how satisfied are you now with the system?", which is anchored by 1=very dissatisfied and 7=very satisfied. Individual net benefits are best measured via improvements in the individual recipient's performance or decision making productivity. This measurement adopted the questionnaire of Millman and Hartwick (1987) and is modified to meet our research purpose. This construct is measured via 13 seven-point likert-type scale items, anchored by 1=extremely small and 7=extremely big.

The two individual factors of computer self-efficacy and personal innovativeness in IT were operationzalized by using the rigorously developed and validated scales described by Agarwal and Prasad (1998) and Compeau and Higgins (1995). Measurements of Usefulness and Ease of Use follow the questionnaires developed by Davis (1989) with minor revisions in order to suit our study. Each of the instruments consists of six items with seven-point scales ranging from 1=Extremely Likely to 7=Extremely Unlikely. Top management support can be operationalized via questionnaire developed by Igbaria (1990), encouraging management support in terms of encouraging the use of the system as well as providing necessary resources. Organizational structure is operationalized by measuring the degree of centralization of management decision-making in the organization. Two questions are adapted from scales developed by Moore & Benbasat (1991) and Zmud (1982).

Research Sample

It is not possible to obtain a random sample in our case, so we use convenient sampling method. We will choose 50 companies from manufacturing, electricity and gas, transport, storage and communications, financing and insurance in Guangzhou, China as samples in this study. In every company, one CEO, one IS manager and 20 employees are invited to participate in our research. The questionnaire is addressed to the IS managers but it contains two detachable parts: part A with questions for the CEO and IS managers (top management support and organizational structure), Part B with questions for the employees related to the IS adoption and implementation being reported on. The questionnaires of employees are to get data about employees' characteristics (computer self-efficacy and personal innovativeness in IT), perceptions about the specific system they are using (ease of use, usefulness), and IS effectiveness at employee's level (system usage, user satisfaction and individual net benefits). Only the paired questionnaires (both parts A and B are returned from the same organization) are valid. Multiple respondents are used in order to increase data validity and reduce the possibility of common method variance (Guimaraes and Igbaria, 1997).

The IS managers are instructed to select the most recently implemented information systems that have been fully operational for at least half a year. The IS managers are encouraged to invite the CEO to fill in the part A questionnaire. Based on the questionnaires from CEOs and IS managers, we could get their opinions on average. In addition, IS managers are also encouraged to randomly select 20 employees in the same organization to participate in our research in order to reduce the chance that IS managers would select their "favorite" end users.

Research Methodology:

This study touches on not only individual level but also organizational level. Organizational factors such as top management support and organizational structure have moderating effects on the relationships among individual characteristics, perceptions of IS and IS effectiveness. Multilevel modeling or hierarchical linear modeling (HLM) is designed to analyze data with a nested structure. It is particularly useful to combine two levels of analysis in a single multilevel model. Data analyses are usually performed using MlwiN or HLM/2, computer packages for multilevel modeling.

MlwiN or HLM/2 splits the total variance of the dependent variable into two residual variances: the residual variance at the individual level and the residual variance at organizational level. Thus, independent variables from individual level and organizational level can be entered into the model to explain the residual variances at both levels. MlwiN can further split the organizational level residual variance of the dependent variable into the residual variance of intercepts and the residual variance of slopes. The residual variance of intercepts refers to the variation in the levels of the dependent variable across organizations. The residual variance of slopes refers to the cross-organizational variation in the relationship between an independent variable and the dependent variable. Multilevel modeling will take into account the statistical interdependence of the responses of individuals at the same organization.

CONCLUSION

IS effectiveness is a multidimensional construct which can not be exhausted by only one single unit of analysis. DeLone and McLean (1992) gave us the research direction to multilevel analysis. However, empirical research using this method in this field is still lacking. This paper extends prior research by offering a conceptual model of the determinants of IS effectiveness that synthesizes individual characteristics, their beliefs of IS and organizational factors. The focus of this integration is on the complexities of the organizational context within which individuals with varying characteristics form their beliefs and lead to IS effectiveness. This paper is expected to enrich IS effectiveness research by organizing and synthesizing the literature on IS, psychological research and organizational research to understand the IS effectiveness better. In addition, another contribution is that this paper proposes an integrated model affecting the IS effectiveness. In this model, we expect to verify whether the antecedents in the adoption stage are still valid in explaining IS effectiveness in the post-adoption stage.

It is by no means claimed here that such a model will be exhaustive. Rather, we expect that the proposed model will be further elaborated on in future work. Furthermore, there is an opportunity to draw upon the rich literature on psychological research and organizational research to gain new insights into IS implementation field. Organizational research provides invaluable insights regarding the importance and measurement of top management support and organizational structure, whereas psychological research and IS research provide equally penetrating ideas on the significance of individual characteristics and cognitions. This paper only gives the theoretical part. We will conduct an empirical study in the future.

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