Technology Adoption in Hospitals – The Roles of System Integration and Technology Support

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Abstract

This research studies how hospital employees react to new HIT systems with an attention to the special IT environment of hospital operations. Two characteristics of the IT environment, system integration and technology support, are identified as contextual constraints that shape the adoption of new HIT systems. A research model is developed based on the established IS theory of the Technology Acceptance Model (TAM). A field study was conducted by surveying employees from two hospitals. The research model is tested and results are discussed.

Keywords

Technology acceptance model, system integration, technology support.

Introduction

In recent years, hospitals have been boosting their investments in information technology (IT) at an unprecedented pace. This is largely because IT, as evidenced in other industries, enhances operation efficiency and improves the overall profitability of business (Raghupathi and Tan, 1999; Chandra et al., 2013). Regulations and federal funding further promote the trend by imposing legal requirements and providing financial supports (Murphy, 2010). For example, the American Recovery and Reinvestment Act and its important Health Information Technology Act provision became law on February 17, 2009, requiring hospitals and physicians to meaningfully adopt and use advanced health information technology (HIT) with an emphasis on electronic health records (EHRs); federal incentives totaling $19 billion were provided to facilitate the adoption of EHRs over a relatively short period of 5 years through 2014.

Thanks to the surge of HIT investment, hospitals have evolved into an IT-intensive industry (Burke et al., 2002). The deployment of HIT systems is necessary but not sufficient for transforming health care (Diamond and Shirky, 2008); to realize the technical potential and achieve desired outcomes, HIT needs to be fully adopted and effectively used (Kolodner et al., 2008). Behavioral research on the adoption of HIT lags behind the fast proliferation of the technology (Burke et al., 2002). There is no hospital-operation-grounded theory to explain how people adopt and use HIT. Researchers and HIT system developers frame HIT adoption with theories that have been validated in other industries without examining the special context of hospital operations. The ignorance of contextual factors may bring about impractical assumptions of the technology environment of hospitals and mislead assessment of HIT without addressing the real problem.

Following Chiasson and Davidson's (2004) call for exploring contextual influences on IS/IT within the healthcare setting, this research studies how hospital employees react to new HIT systems with an attention to the special IT environment of hospital operations. The paper is structured as follows. First, the IS literature is briefly reviewed on the study of system adoption. Two characteristics of the operation environment, system integration and technology support, are identified as contextual constraints that shape the adoption of new HIT systems. A field study is conducted in two hospitals. The paper ends with a discussion of the implications of the results for both HIT researchers and practitioners.

Research Model and Hypotheses

In this study, TAM serves as the basis for the development of the research model as depicted in Figure 1.

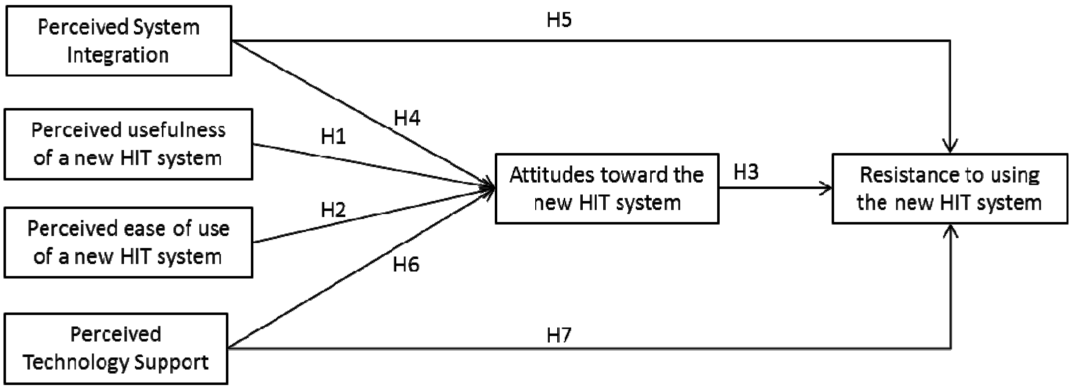


Figure 1. Research Model

TAM Model and Technology Adoption

In 1989, Davis (1989) proposed the technology acceptance model (TAM) to explain a potential user's behavioral intention to use a technological innovation in organizational settings. After two decades of intensive research, TAM is widely recognized as a dominant IS theory in the study of user behaviors (King and He, 2006), and has been applied by many researchers in their study of HIT adoption and use (e.g., Chau and Hu, 2001; James et al, 2006; Bhattacherjee and Hikmet, 2008; Djamasbi et al., 2009; Lin et al., 2012). TAM posits that one's behavioral intention to adopt/use a certain technology is largely shaped by the person's attitudes (defined as the positive or negative fillings about the target technology), which is determined jointly by the perceived ease of use (defined as the expected effort of using the technology) and the perceived usefulness (defined as the assessment on the ability of enhancing his/her work performance) of the target technology.

TAM is mostly applied for the assessment of an existing technology. However, it can also predict the adoption of a new technology with which users have no previous experience. For example, in a longitudinal study of software development, Davis and Venkatesh (2004) find that TAM provides reliable prediction on the behavior of prospective users before they have direct hand-on experience with a new system; based on a brief knowledge of system features and functionalities, users make assessments that accurately reflect their future usage behavior. In another study of users' acceptance of a new self-service technology (Marler et al., 2009), TAM provides valid predictions both before and after the implementation of the technology.

This research studies hospital employees' reactions to the introduction of a new HIT system. Two hypotheses are developed to predict one's attitudes toward the new HIT system.

> *H1. One's perceived usefulness of a new HIT system is positively associated with the person's attitudes toward the new HIT system.*

> *H2. One's perceived ease of use of a new HIT system is positively associated with the person's attitudes toward the new HIT system.*

TAM posits that one's attitudes about a technology lead to the person's behavioral intention of using or resisting the technology. The following hypothesis is developed.

> *H3: One's attitudes toward a new HIT system is negatively associated with the person's resistance to using the new HIT system.*

Contextual Factors

The IT environment of hospital operations differ significantly from other industries. On the one hand, hospitals is an IT-intensive industry; hospital nurses and physicians spend much time working with computer-based clinic application systems in their daily undertaking of health care service, and "computers ... are conveniently located at every corner" (Chandra et al., 2013; p. 71). On the other hand, hospitals are popularly assessed to lag other industries in IT adoption by 10 to 15 years (Raghupathi and Tan, 1999). Many hospitals are still on an early-computer-era stage of "buying the latest technology without knowing how it might effectively be employed in achieving business goals" (Khati, 2006; p. 73). This assessment is based on the long standing observation that "few hospitals have truly integrated systems with up-to-date financial, clinical, competitor, and environmental information" (Austin et al., 1995; p. 30), which remains true today (HIMSS, 2012).

The IS literature has long recognized the importance of system integration, which refers to that functional information systems speak to each other and that functional activities are highly interrelated and handled together (Morabito et al., 2010). Integrated information systems help organizations not merely in automating business activities, but also reshaping and redesigning business processes (Venkatraman, 1991). The best example of system integration may be the implementation of enterprise resources planning systems (ERPs), which have emerged as the enterprise backbone of modern organizations (Nah et al., 2001). In IS empirical research, system integration is viewed as a dimension of system quality (DeLong and McLean, 1992; 2003) and can be surrogated by other quality measures such as ease of use and usefulness. In the hospital industry, however, the assumption that quality system must integrate across functions and systems may not hold true.

Healthcare is featured with fragmented services (Chaudhry et al., 2006). Clinic application systems are often developed in isolation to fulfil specific tasks. HIT systems are "... characterized as a series of standalone systems with little integration." (Burke and Menachemin, 2004; p. 208). The lack of system integration in hospitals is rarely observed in other industries (Austin et al., 1995; Chandra et al., 2013). This study posits system integration as an environmental factor that depicts the special context of hospital operations.

The lack of system integration implies that hospital employees have to work on different systems to handle different tasks. Given the fragmented nature of healthcare and the large volume of transactions (Chaudhry et al., 2006), hospital employees will be frustrated with inefficiency when they switch between systems and work with interrupted business processes. Such a frustration will make hospital employees sensitive to the integration level of systems being used in their workplace, and affect their reactions to the deployment of new HIT systems. When a new HIT system is introduced, prospective users will develop their reactions partially based on the system's capability of integrating with other systems. If the system is perceived as of low levels of system integration, hospital employees will develop negative attitudes toward the new system and are likely to resist using the new system; if the new system is perceived of high levels of system integration, hospital employees will develop favorable view of the new system and are unlikely to resist using the system. The following hypotheses are developed:

> *H4: One's perceived level of system integration is positively associated with the person's attitudes toward a new HIT system.*
>
> *H5: One's perceived level of system integration is negatively associated with the person's resistance to using the new HIT system.*

IS researchers find that support from organizations significantly affects one's attitudes and intention of using a system. Such support, depends on the scope, may be labeled differently. For example, Taylor and Todd (1995) proposed Behavioral Control for "perceptions of internal and external constraints on behavior" (p. 149), and Thompson and colleagues (Thompson et al., 1994) developed a construct of Facilitating Conditions, which is defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system. This study adopts the concept of Technology Support, which is defined as the technical support that a user receives on using information technology and systems in workplace.

Technology Support is argued to be another factor that distinguishes the operation environment of hospitals from that of other industries. Unlike other industries where IT department plays a central role in providing technology support on system use, training, and education, hospital IT departments often limit their responsibilities to network administration and system maintenance. This is not surprising since IT professionals lack the understanding of HIT systems. The use of HIT systems, especially clinic application systems that dominate hospital operations, requires specialized domain knowledge in medicine and healthcare service; such knowledge is unlikely to acquire without special education. Similarly, healthcare professionals are not equipped with profound IT knowledge to cope with the fast pace of IT development. In an environment where interactions between IT departments and user departments are comparatively limited, the importance of technology support may be more salient. When introducing a new HIT system, if users believe the support is in place, they will develop positive attitudes and are likely adopt the system; otherwise, users may view using the new system a daunting task.

> *H6: One's perceived technology support is positively associated with the person's attitudes toward a new HIT system.*

> *H7: One's perceived technology support is negatively associated with the person's resistance to using the new HIT system.*

Research Methods and Results

Research Design

A field study was designed to test the proposed research model. Two midsized hospitals agreed to participate in the study. With the permission from the top management of the two hospitals, survey invitations were sent to the hospital employees via email.

Measurement

In the study, six constructs need to be operationalized. They include perceived system integration, perceived technology support, perceived usefulness of a new HIT system, perceived ease of use of a new HIT system, attitudes toward the new HIT system, and resistance to using the new HIT system.

Perceived System Integration

Perceived system integration was measured with three items that were developed from the definition of system integration (Morabito et al., 2010). Respondents were asked whether they expect a new system to integrate, communicate, and share data with other systems.

Perceived Technology Support

Perceived technology support was adapted from the construct of Facilitating Conditions that was developed by Thompson and colleagues (Thompson et al. 1991). Questions were reworded with an emphasis on technical support on system use that a hospital employee might receive from IT department, user department, vendor, and colleagues.

Perceived Usefulness, Perceived Ease of Use, Attitudes, and Resistance

The four constructs of perceived usefulness of a new HIT system, perceived ease of use of a new HIT system, attitudes toward the new HIT system, and resistance to using the new HIT system were all adapted from a seminal TAM study of Venkatesh et al. (2003).

Participants

The two participating hospitals had about 4000 employees. 253 people responded to the survey invitation by clicking on the embedded survey link. The job positions of the respondents are reported in Table 1. One may note that the respondents were dominated by nurses.

Job Positions	Counts
Physician	5
Specialist	13
Registered Nurse	158
Practical Nurse	16
Manager	14

Director	10
Executive	1
Total	250

Table 1. Job Positions of Respondents

Data Analysis

Not all submitted answers were complete. After dropping records with missing values, 151 answers remained for further data analysis.

The test of construct validity was conducted with Partial Least Squares (PLS) – a structural equation modeling (SEM) technique that has been commonly used in IS research. Similar to other SEM techniques (e.g., LISREL), PLS tests the validity of constructs and the structural model at the same time, and is therefore considered methodologically rigorous when compared with regression-based techniques who separate the test of construct validity (e.g., factor analysis) from the test of the research model (Gefen et al., 2000). In addition, PLS is the favorable choice when the sample size is not very large.

Assessing the validity of reflective items follows the conventional practice based on the examination of construct reliability, convergent validity, and discriminant validity. Construct validity can be assessed by composite reliability calculated in PLS (should be larger than 0.70). Convergent validity can be assessed by the average variance extracted (AVE) among measures (should be larger than 0.50). Discriminant validity can be assessed by comparing the square root of AVEs and inter-construct correlations – the former should be larger than the latter to support disciminant validity. Close examination of Table 2 suggested that all the conditions were satisfied. Thus, validity of the reflective indicators under study was concluded.

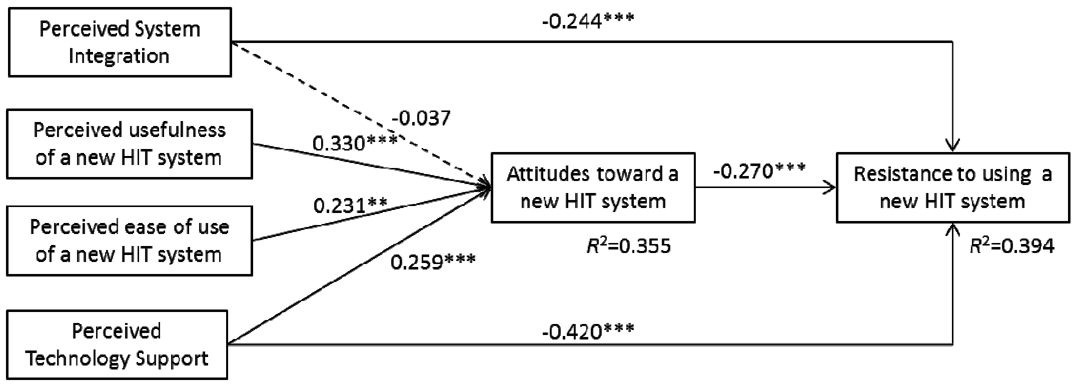
	Composite Reliability	1	2	3	4	5	6
1. Perceived system integration	0.90	**0.75**					
2. Perceived technology support	0.94	-0.01	**0.75**				
3. Perceived usefulness of a new HIT system	0.93	0.01	0.20	**0.81**			
4. Perceived ease of use of a new HIT system	0.82	0.20	0.21	0.45	**0.60**		
5. Attitudes toward the new HIT system	0.91	0.01	0.37	0.69	0.43	**0.72**	
6. Resistance to using the new HIT system	0.93	-0.25	-0.52	-0.17	-0.33	-0.43	**0.87**

Note: Numbers in bold on the leading diagonal are the average variance extracted (AVE).

Table 2. Inter-Construct Correlations

Hypothesis Testing

The research model was tested with PLS-Graph 3.0. The resulted path coefficients of hypothesized relationships are reported in Figure 2, in which dashed lines indicate insignificant paths at α=0.05 level.



Note: * p<0.05, ** p<0.01, *** p<0.001; dashed line indicates insignificance

Figure 2. Testing Results

Overall, testing results lend strong support to the proposed research model. Most relationships were concluded with hypothesized directions and statistical significance with the exception of H3, which hypothesizes a positive effect of perceived system integration on attitudes toward a new HIT system. The explained variances are 35.5% for Attitudes and 39.4% for Resistance to using a new HIT system. These statistics demonstrate good model fit (Gefen et al 2000).

A close examination of the testing results suggests that the two primary TAM predictors, perceived usefulness and perceived ease of use of a new HIT system, provide limited explanation of the variance among users' resistance to using a new HIT system. The two contextual factors, perceived system integration and perceived technology support, appear to be more important in predicting whether the target new system will be adopted or resisted. A further discussion on the findings is provided in the following section.

Discussion

This research studies the adoption of new HIT systems among hospital employees. Extending TAM with two factors of perceived system integration and perceived technology support, a research model is developed and tested. The results provide strong implications for researchers and practitioners on developing and implementing HIT systems.

TAM posits that users will adopt a new technology if they view the technology useful and easy to use. The proposition holds true for the research sample. The two primary predictors of perceived ease of use and perceived usefulness exert significant effects on users' intention of adopting or resisting a target HIT. One may note that magnitudes of such effects are moderate in comparison to the general findings of TAM research (e.g., King and He, 2006). This is probably because the target HIT is a new system with witch prospective users had little hand-on experience. The results not only confirm the robustness of TAM for predicting users' reactions to a new system, but also imply that feedback from users based on an initial understanding of the proposed new system can be used in predicting users' future acceptance of the system. The latter is of particular importance to system developers. Before committing significant resources to develop a new system, system developers should communicate and verify system requirements with users and seek evaluations for predictive assessment of system success (Davis and Venkatesh, 2004).

Two contextual factors, perceived system integration and perceived technology support, were hypothesized to affect users' reactions to the target new HIT system. The results in general lend strong support to the hypotheses. Indeed, the total effects of the two contextual factors on users' behavioral intention are larger than that of the two TAM predictors (see Table 3, in which the total effects are calculated using the procedure of Davis (1989)).

Predictors	Total Effects
perceived usefulness of a new HIT system	0.089

perceived ease of use of a new HIT system	0.062
perceived system integration	0.234
perceived technology support	0.490

Table 3. Predictors' Total Effects on Users' Resistance to Using the New HIT System

The results have strong implications for hospital management and HIT practitioners. For hospital management, when deploying a new HIT system, special attention should be placed on building an environment where people can easily seek technology support on using the system. People will be much motivated to use the system if such support is obvious and perceivable. For HIT system developers, new HIT systems should integrate with existing systems even if system integration is not required or of low priority. An integrated system that can communicate with other systems, support multiple applications, and/or share data with others will receive favorable reactions from prospective users.

Interestingly, the direct effect of perceived system integration on attitudes is not significant. This suggests that prospective users may develop positive attitudes of a new HIT system even if the system does not integrate with others. Positive attitudes with the system will be formed if the system is perceived as useful and easy to use. However, the direct effect of perceived system integration on behavioral intention, measured in the study as the expected resistance to using the new HIT system, is significant. Indeed, the total effect of perceived system integration on behavioral intention is much larger than that of perceived usefulness and perceived ease of use. Therefore, the importance of system integration in motivating prospective users should not be underestimated. To some extent, the capability of integrating with other systems is of more importance than the technical functions and features of the system in motivating initial use of the system among users.

As with other empirical work, this study is subject to limitations. One limitation was the low response rate and associated small sample size. Although the study had received support from the top management of the two participating hospitals, the response rate was low (about 6.3%) and the final effective sample was of small size (n=151). This is probably caused by the inconvenience of taking survey by the participants. Nurses of the two hospitals do not have computers assigned for their individual use; they have to share computers in their workplace. In addition, hospital employees are in general not encouraged to work at home. As such, the survey has to be taken during the regular work time, which may be very cumbersome and easily interrupted due to the busy work schedule.

All constructs in the study were measured by self-reported answers. Thus, common-method bias could be another concern for the study. But close examination of the correlation matrix (Table 2) reveals that correlations among investigated constructs are moderate and some are insignificant, suggesting that relationships among data are unlikely to be exaggerated by the use of survey. To further test the existence of common-method bias, Harman's single factor test was performed by loading all of the items in this study into an exploratory factor analysis. The variance extracted from a single factor was 29%, providing evidence that there is no substantial common method variance present.

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