Moving Hospitals Toward E-Learning Adoption: An Empirical Investigation

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Abstract

Purpose – Medical errors cause a significant number of deaths. Providing training to medical staff can improve the quality of medical care. Hospitals have traditionally used face-to-face modality to train staff but they are beginning to adopt e-learning systems that can easily deliver training at work or to other convenient locations. The purpose of this paper is to investigate factors leading to e-learning adoption in hospitals.

Design/methodology/approach – A framework of factors leading to the adoption decision of e-learning systems is first proposed. Survey data are collected to empirically test the proposed framework. The samples consist of senior executives and managers in hospitals.

Findings – It is found that three factors including managerial, organizational, and technological exhibit significant influences on the adoption decision. One novel result is that the organizational variable of hospital specialization significantly influences the decision to adopt e-learning systems.

Research limitations/implications – This study is one of the first to propose a model of adoption of e-learning specifically in the context of hospitals. Limitations and strengths of the study and possible future research direction are also discussed.

Practical implications – From a practitioner's standpoint, the results of this study can help hospital administrators to accelerate the adoption of e-learning systems.

Originality/value – This study is one of the first to propose a model of adoption of e-learning specifically in the context of hospitals. It is expected that the model developed can assist to further understand the e-learning adoption in hospitals.

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E-learning Adoption: An Empirical

Preamble

Medical errors are the fourth leading cause of death in the USA, more than the annual fatalities due to motor vehicle accidents (43,458), breast cancer (42,297), or HIV/AIDS (16,516). A total of 64 persons every day die as a result of medical errors in the UK (Khoumbati *et al.*, 2003) and 44,000-98,000 people every year die as a result of medical errors in the USA (Kohn and Corrigan, 2000).

In addition to medical errors, hospitals are facing challenges in dealing with many systematic problems including overstretched staff, limited resources, operational inefficiency, slow response time, uncertain quality of care, lack of disaster readiness, and poor coordination and communications across functional departments. Although there is no one single solution, training the healthcare staff on medical knowledge and regulations can improve the quality of medical care (Harris, 2004). In fact, medical errors along with ever-changing government regulations are driving the healthcare industry to embrace information technology (IT) solutions. Hospitals often resort to technological solutions to overcome these problems (Kimberly and Evanisko, 1981). One particular IT solution has been electronic learning or e-learning. The healthcare industry – pharmaceuticals, medical device manufacturers, and hospitals – are adopting e-learning systems to increase the efficiency at which training and education are delivered. e-Learning training programs can be easily delivered at the caregiver's main office or other work sites and locations, thus reducing travel time for busy professionals.

In addition, the recognition of national accreditation bodies, such as the Council on Education for Public Health, the National League for Nursing Accrediting Commission, and the Commission on Collegiate Nursing Education, has contributed to the increased offerings of professionally accredited, online nursing and public health degree programs, as well as to the recognition that e-learning is a legitimate education and training modality in healthcare fields. A total of 68 accredited online degree programs are currently available in the nursing field, and 18 programs are available in the public health field according to of the *US News' E-Learning Guide* (*US News and World Report*, 2006).

Many hospitals acknowledge the importance of continuously and efficiently training and educating their clinical staff to reduce medical errors and master new applications. These organizations also recognize the potential of e-learning to provide training at work, and many have begun implementing online medical programs for their staff and caregivers. A prominent development in medical e-learning for hospitals is the recent establishment of an online learning system by The Radiology Integrated Training Initiative (RITI). The RITI is a single access point for all radiology trainees in the UK to receive and renew training for radiologists (Barlow, 2006). The online learning system includes archives of clinical cases, problem-solving exercises, and trainee progress reports. Another example is the Sinai E-Learning System that offers online medical programs to caregivers; this system is developed by Toronto's Mount Sinai Hospital affiliates in partnership with the University of Toronto (Sanli, 2005). Also, the mental healthcare solution provider Priory offers an online learning management system that delivers online clinical and education programs to 47 acute hospitals, rehabilitation centers and specialist schools (Innes-Farquhar, 2006).

Despite the success of these early adopters, the $2 billion healthcare sector in the USA is lagging behind in e-learning adoption (Alsever *et al.*, 2006). The increased adoption of e-learning seen in the educational sector is not found in the healthcare sector, especially hospitals. Hospitals have been slow adopters of new technology (Wicks *et al.*, 2006). E-learning systems are considered new technologies and are not in the strategic plan of many hospitals. To date, the information systems literature has not devoted much attention to this relatively new area of healthcare e-learning, especially in the context of hospitals (which are very different from traditional business

organizations). This study seeks to investigate the factors that contribute to a hospital's decision to adopt e-learning systems. To understand hospitals' move from traditional training to e-learning, the present research first develops a framework of determinants of e-learning adoption; it then conducts a study to empirically test the proposed framework. Implications of the results are also discussed.

Theoretical development

This study examines the influences of different antecedents on a hospital's decision to adopt e-learning systems and programs. Managerial, organizational, and technological factors can influence the decision of an organization to adopt a technological innovation (Tornatzky and Fleischer, 1990). Managerial factors comprise of top management support and receptivity to e-learning systems. Organizational factors consist of hospital size, degree of specialization, functional differentiation, and organizational culture. Technological factors consist of compatibility with existing systems, complexity of the adopted system, and economic cost of the adopted system.

Managerial factors

Adoption decisions of novelty technology like e-learning are influenced by two managerial factors: degree of support of top management and degree of receptivity of top management (Thong, 1999; Yap *et al.*, 1992). A study of the innovation of small- and medium-sized firms finds that top management and/or decision makers play an important role in the final decision of adopting innovative technologies (Thong, 1999).

Additionally, the degree of top management receptivity to novelty technology has a salient positive effect on the decision to adopt it (Yap *et al.*, 1992). For instance, chief executive officer's (CEO's) personality, educational background, support, computer literacy, leadership, and communication ability were found to affect the adoption of IT in an organization (DeLone and McLean, 1992). At the same time, CEO's creativity (Kirton, 1976), knowledge about the technology (Attewell, 1992; Thong, 1999), and the positive attitude of CEO towards adopting new IT (Thong and Yap, 1995) can affect decisions to adopt.

Most caregivers in a hospital do not consider e-learning systems a core technology in their operation. It is therefore reasonable to anticipate a certain level of resistance from caregivers to adopt e-learning systems. The higher resistance users have to novelty technology, the stronger top management support is necessary for successful adoption (Damanpour, 1991; Premkumar and Roberts, 1999). For instance, top management endorsement of learners' success is an important cornerstone for e-learning initiatives (Arora, 2006). Therefore, we posit that top management support and the degree of top management receptivity to novelty technology are two major forces behind the adoption decision of e-learning systems in hospitals:

H1a. The degree of support of top management has a positive influence on the decision to adopt e-learning systems in hospitals.

H1b. The degree of receptivity to novelty technology by top management has a positive influence on the decision to adopt e-learning systems in hospitals.

Organizational factors

The healthcare industry has been known for its change-averse culture and fragmented structure (Parnell, 2004). Because of these industry-specific characteristics, capital

planning and purchasing decisions for IT are largely made at the individual hospital level (Jaklevic, 2004). In addition, hospitals vary in size, specialization, functional differentiation, and organizational culture, and these organizational characteristics further complicate the decision-making process of a hospital to adopt a new technology (Damanpour, 1991; Kimberly and Evanisko, 1981).

Robbins (1990) has identified complexity as a factor for organizational structure. Complexity of organizational structure can be further divided into specialization, functional differentiation and professionalism, and these factors have been found to have a strong positive influence on IT adoption (Damanpour, 1991). Specialization and functional differentiation are particularly important for IT adoption decisions in hospitals (Kimberly and Evanisko, 1981). As an organization grows in size, not only do these organizational factors grow in complexity, but also does leveraging IT become more important for efficient operations (Fiorito *et al.*, 2000).

Organizational culture is another important factor contributing to IT adoption. Organizational culture dictates the formal and informal way members interact with each other and with people outside the organization (Deshpande and Farley, 1999). Members belonged to the same organizational culture share the similar values, norms, assumptions, beliefs and ways of living (Hill and Jones, 2001). Within the innovation-friendly or innovation-encouraging culture, organizational members are receptive to the adoption of new practices and technologies and are actively applying them to add value to the existing practices. The readiness of managerial IT knowledge and open communication channels, for instance, are important elements of absorptive capacity; that is, the ability for an organization to innovate itself (Cohen and Levinthal, 1990). Administrators can increase a hospital's absorptive capacity by promoting an innovation-friendly culture, such as valuing of change, efficiency and goal setting (Caccia-Bava *et al.*, 2006). Organizations can also be restructured to affect the formation of organizational innovative culture and vice versa (Handy, 1985). All these cultural elements or the residuals of success (Schein, 2005) could be placed within an organization to be shared by its members in order for top administrators to make needed decisions to try new technologies in hospitals. An innovative organizational culture can encourage novelty technology before they are widely accepted (Wallach, 1983). A high-innovative organizational culture is more likely to result in the fast IT adoption decision (Fink, 1998; Kitchell, 1995).

In the context of e-learning in hospitals, e-learning systems allow the delivery of medical education and training anytime, anywhere. e-Learning systems transcend departments within a hospital and across hospitals. In order to clearly understand the major forces behind the decision to adopt e-learning systems in hospitals, it is important to investigate pertinent organizational factors including hospital size, specialization, functional differentiation, and organizational culture. Specifically, hospital size and organizational culture are the outcomes of organizational design, whereas specialization and functional differentiation are organizational structural factors that can enhance operational efficiency (Schneller and Smeltzer, 2006). Therefore, it is imperative to take both organizational design (size and culture) and structure (specialization and functional differentiation) into consideration to understand e-learning system adoption in hospitals. The resulting four hypotheses are as follows:

H2a. Hospital size has a positive influence on the decision to adopt e-learning systems.

H2b. The degree of specialization of hospitals has a positive influence on the decision to adopt e-learning systems.

H2c. The degree of functional differentiation of hospitals has a positive influence on the decision to adopt e-learning systems.

H2d. The innovation-friendly organizational culture has a positive influence on the decision to adopt e-learning systems.

Technological factors

Technological factors primarily consist of complexity of the adopted system, compatibility with existing systems, and economic cost of the adopted system; technological factors were found to influence the adoption of e-learning systems by nurses, paramedics, and physicians (Spanjers *et al.*, 2005). In terms of complexity, the degree of complexity of the adopted system can be measured in two dimensions: depth and width (Wang and Tunzelmann, 2000). Complexity in depth refers to the sophistication of the adopted e-learning system. Complexity in breadth refers to the range of areas that need to be addressed before realizing the benefit of the adopted system. Users have more difficulty understanding complex e-learning systems; thus, they are less likely to adopt an e-learning system with a high degree of technical complexity.

In terms of compatibility, if a new e-learning system cannot readily overlay on top of or operate with existing systems and infrastructure (on which a hospital has already invested heavily), then it is not likely that the adoption decision will be favorable toward such a system. In fact, incompatibility with existing systems, difficulty of using the new system, and underestimating the impact of technology changes to users are the major causes of failure of e-learning system implementations (Overton, 2006). In terms of economic cost, the success of many IS projects is highly contingent on its being a cost-effective solution (Bingi *et al.*, 1999; Premkumar and Roberts, 1999; Tornatzky and Klein, 1982), thus a lower cost should increase the likelihood of e-learning adoptions in hospitals. It is commonly perceived that e-learning is more cost-effective than the traditional classroom-based training (Whalen and Wright, 1999). Although the up-front investment of an e-learning program is high, the marginal cost of adding an additional learner is minimal (Mackay and Stockport, 2006). Other metrics that assess cost-effectiveness include the real-time delivery and updates of course materials (Dulworth and Shea, 1995), high-learning availability (i.e. 24 £ 7), and scalable classroom size without the constraint of physical facilities (Beam and Cameron, 1998). For example, National Health Service received the 2003 "E-Learning Project of the Year" award primarily because it was able to lower the training cost of its e-learning program to as little as 50 cents per clinical staff (Young, 2003). As the healthcare industry expands to serve more aging baby boomers in the USA, the lower marginal cost should make e-learning an attractive and viable training solution for hospitals.

Therefore, e-learning systems compatibility with existing systems, its complexity, and economic cost must be considered to understand adoption decisions at hospitals. The three associated hypotheses are:

H3a. The incompatibility with existing systems has a negative influence on the decision to adopt e-learning systems.

H3b. The complexity of the system has a negative influence on the decision to adopt e-learning systems.

H3c. The economic cost of the system has a negative influence on the decision to adopt e-learning systems.

Together, managerial, organizational, and technological factors constitute an integrated framework to understand the decision to adopt e-learning systems. The hypothesized relationships are shown in Figure 1.

Research methodology

A survey methodology was used to investigate if the identified managerial, organizational, and technological factors influence the decision of hospitals in adopting e-learning systems. The target organizations consisted of 508 hospitals in Taiwan.

Instrument

To establish a research stream to prior literature, we adopted previously validated instruments so that cooperative research efforts can be promoted in the community (Hunter *et al.*, 1983). Published instruments were used because reliability and validity for the items had already been substantiated in prior studies. In addition, using validated instruments and agreed-upon constructs, researchers can continue the research stream, conduct confirmatory, follow-up research across different settings and times, and support triangulation of results (Cook and Campbell, 1979). This way, the results can be consistently interpreted in light of the past literature in the area. In the long run, this approach can help to alleviate the confounding that is found in many IS research projects (Straub, 1989).

Managerial factor – degree of receptivity by top management. We adopted Thong and Yap's (1995) instrument used to measure the degree of receptivity and attitude of top management towards e-learning project adoption. A Likert-type scale ranging from 1 to 5 (1 – very unsatisfied; 5 – very satisfied) was used. A score of 5 means top management is very receptive towards e-learning system adoption; a score of 1 means it is not very receptive.

Managerial factor – top management support. The instrument for top management support was adopted from that used by Premkumar and Roberts (1999) and Yap *et al.* (1994). The adopted instrument was used in prior studies to assess the degree of top management involvement in planning, allocation of resources, and attention to e-learning projects. A Likert-type scale ranging 1 to 5 (1 – strongly disagree; 5 – strongly agree) was used. A score of 5 means high top management support; and a score of 1 means low top management support.

Organizational factor – hospital size, specialization, and functional differentiation. We adopted Kimberly and Evanisko's (1981) instrument for measuring hospital size, specialization, and functional differentiation. Hospital size was assessed based on the number of staff employed in the hospital; a high number of staff indicates a large hospital size. Specialization was calculated based on the number of departments established in the hospital; more departments indicate more specializations. Functional differentiation is the extent to which a hospital is divided into a number of subunits

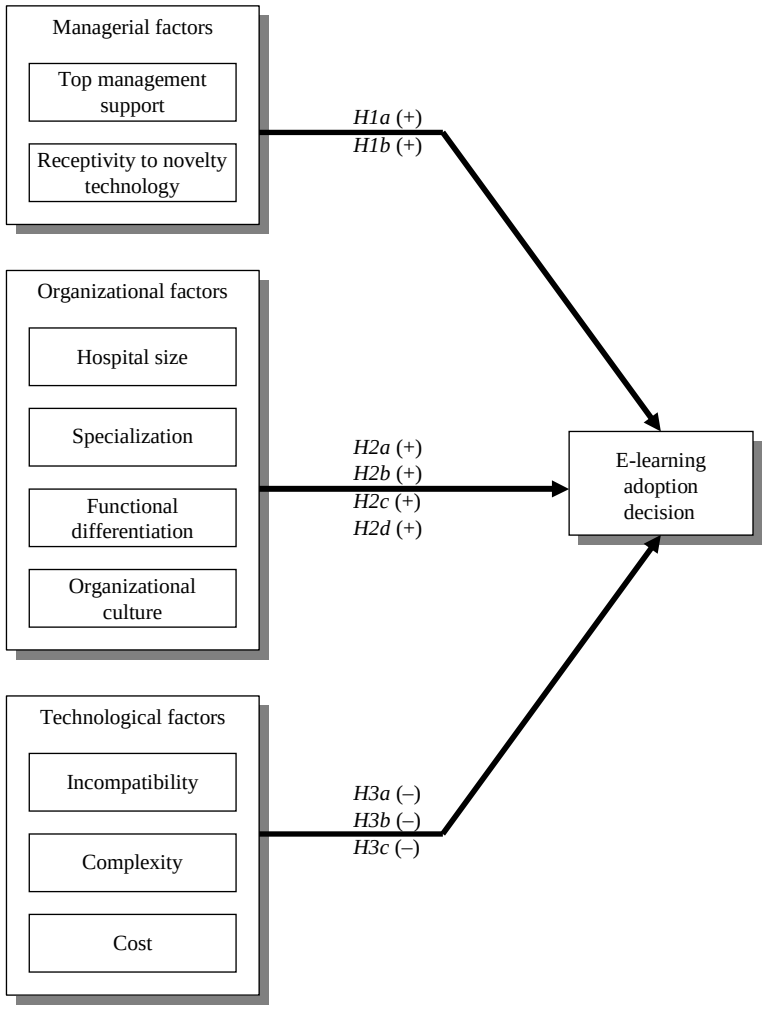

Figure 1.
Framework for e-learning adoption decision

(Kimberly and Evanisko, 1981); the degree of functional differentiation is higher if the number of administrative units in a hospital is larger.

Organizational factor – organizational culture. The measure for organizational culture was adapted from Deshpande and Farley's (1999) instrument. We asked subjects to assess their organizational culture along two dimensions: bureaucratic and innovative. For bureaucratic, four items corresponding to bureaucratic tendencies in organization type, leadership, organization cohesiveness, and values were used. For innovative, four items corresponding to innovative tendencies in time-to-market, market growth, market maturity, and technology were used. Each item was measured using a five-point Likert-type scale.

Technological factor – complexity. We adopted Premkumar and Roberts' (1999) instrument for technological complexity. This instrument assesses how involved are the required skills to implement the technology, as well as how difficult it is to assimilate the technology with existing work practices.

Technological factor – economic cost. We adopted Premkumar and Ramamurthy's (1999) instrument for economic cost. This instrument was used to measure the economic cost of system implementation including deployment, maintenance, and training. The cost measured includes all costs associated with hardware, software, people, data, and procedure.

Dependent variable – e-learning adoption decision. The instrument for adoption decision was taken from Chau and Tam (1997). Respondents were first asked if they were currently adopting e-learning systems. Those who answered "Yes" were then asked to choose from three stages of e-learning system adoption:

(1) We have allocated a budget for e-learning projects and are in the planning stage.
(2) E-learning projects have been approved and adoption work is in progress.
(3) We are currently using e-learning systems.

Hospitals that have adopted e-learning systems are those that have responded "Yes" and have selected one of these three stages.

Procedure

Five management information systems experts were first invited to participate in a pilot test of the survey instrument. The purpose of the pilot test was for the manipulative check of content validity and questionnaire reliability. After the pilot test, the survey instrument was modified to reflect changes recommended by the experts. The modified instrument was then distributed to directors, associate directors, and other senior MIS managers at 508 hospitals in Taiwan. Participants were selected due to their active leadership in their hospitals' e-learning initiatives.

Follow-up phone calls were made to non-respondents a month after the initial survey distribution. A total of 99 questionnaires were collected. Five respondents were dropped due to duplication and incomplete responses on the questionnaire. As a result, a total of 94 valid questionnaires were used for this study – yielding a response rate of 18.5 percent. This response rate was within the acceptable range of 17-28 percent for IS research (Pinsonneault and Kraemer, 1993).

Results

Respondent characteristics

Table I shows the demographic characteristics of the respondents which were collected as part of the survey. About 60 percent of the hospitals had already adopted e-learning systems, whereas 40 percent of them had not. The respondents also reported that their hospitals were at different stages of the e-learning system adoption: planning, development, and implementation; some respondents reported that their hospitals had no plans. Adoption profiles for participant hospitals are shown in Table II.

Item	Categories	Sample size	Percentage
Gender	Male	66	70.2
	Female	28	29.8
Age	Under 29	15	16.0
	30-34	14	14.9
	35-39	23	24.5
	40-44	25	26.6
	45-49	12	12.8
	Above 49	5	5.3
Years of experience with current job	Less than one year	10	10.6
	1-3 years	26	27.7
	4-6 years	24	25.5
	7-9 years	18	19.1
	Over nine years	16	17.0
Years of experience in the healthcare industry	Less than five years	27	28.7
	6-10 years	23	24.5
	11-15 years	22	23.4
	16-20 years	10	10.6
	21-25 years	6	6.4
	26-30 years	4	4.3
	Over 30 years	2	2.1
Job positions	MIS director	43	45.7
	MIS vice director	4	4.3
	Other top managers	47	50.0

Table I. Demographic data

	Size	Percentage
Adoption stages		
Planning stage	18	19.1
Development stage	7	7.4
Implementation stage	31	33.0
Has not considered adoption	38	40.1
Hospitals adopting e-learning systems		
Already adopted e-learning system	56	59.6
Have not adopted e-learning systems	38	40.4

Table II. Adoption profile

Scales and measurement properties of the survey instrument

Table III shows that Cronbach's α values for all constructs exceed the recommended 0.6 (Nunnally, 1978) or 0.7 (Churchill, 1979), indicating that measurements of theoretical constructs have consistent reliability. The Cronbach's α results indicate that the survey instrument can reliably measure the studied constructs.

The content validity of the survey instrument was validated by content experts after the pilot test. In addition, we assessed the construct validity of the modified survey instrument. Specifically, we adopted the principal component analysis method and rotated the analysis results to maximize the variance (varimax method) in order to reduce the number of variables and detect structure in the relationships between variables (Thurstone, 1931). Table IV shows the results of Kaiser-Meyer-Olkin (KMO) and Bartlett tests. The results confirm that all constructs exceed the threshold value of

Constructs	Variables	No. of items	Cronbach's α
Managerial construct	Top management receptivity	3	0.8118
	Top management support	3	0.9507
Organizational construct	Hospital size	1	N/A
	Specialization	1	N/A
	Functional differentiation	1	N/A
	Organizational culture		
	Bureaucratic	4	0.8656
	Innovative	4	0.8733
Technological construct	Incompatibility	1	N/A
	Complexity	1	N/A
	Cost	3	0.8934

Table III.
Cronbach's α reliability test

		Bartlett test		
Constructs	KMO	x^2	df	p-value
Managerial	0.704	228.308	15	0.000
Organizational	0.885	923.560	55	0.000
Technological	0.746	289.908	15	0.000

Table IV.
KMO and Bartlett tests

0.5 (p ¼ 0.000) which show that measures of sampling in this study were adequate and a further factor analysis was warranted. Table V shows the factor loading analysis of items used to measure the theoretical constructs. All items within each construct exceed the threshold value of 0.5 (Hair *et al.*, 1998). These results indicate that the constructs have sufficient psychometric validity.

	1	2	3	4
Attitude 1	0.911			
Attitude 2	0.890			
Attitude 3	0.695			
Management support 1		0.887		
Management support 2		0.930		
Management support 3		0.923		
Organizational culture 1			0.645	
Organizational culture 2			0.738	
Organizational culture 3			0.718	
Organizational culture 4			0.867	
Organizational culture 5			0.833	
Organizational culture 6			0.803	
Organizational culture 7			0.785	
Organizational culture 8			0.787	
Cost 1				0.890
Cost 2				0.914
Cost 3				0.866

Table V.
Factor loading analysis of survey items

Factor analysis

Following the factor loading analysis we conducted discriminant analysis to examine the hypothesized relationships of the theoretical model. Discriminant analysis is applicable to this study because the dependent variable is categorical in nature – adopt or not adopt. The result is that the proposed model (shown in Figure 1) is significant; Wilks' λ value is 0.526 (χ^2 = 54.358, df = 12, p = 0.000), which exceeds the threshold value of 0.3 (Davis *et al.*, 1987). Thus, it is reasonable to deduce that the managerial, organizational and technological constructs together can influence the decision to adopt or not adopt e-learning systems.

In addition, we further performed discriminant analysis for each construct. A closer examination of individual variables within each construct shows that they can significantly predict change in the adoption decision. Managerial construct, consisting of the degree of receptivity towards the adoption of e-learning systems (loading = 0.436, $p < 0.01$) and top management support (loading = 0.494, $p < 0.01$), allows us to discriminate between adopting and non-adopting hospitals. With more receptivity and higher support of top management, hospitals are more likely to adopt e-learning systems. Thus, *H1a* and *H1b* are supported.

Organizational construct, comprised of hospital size (loading = 0.572, $p < 0.01$), specialization (loading = 0.623, $p < 0.01$), functional differentiation (loading = 0.655, $p < 0.01$), organizational culture-bureaucratic (loading = 0.303, $p < 0.01$), and organizational culture-innovative (loading = 0.360, $p < 0.01$) allows us to discriminate between adopting and non-adopting hospitals. These variables all have a positive influence on the dependent variable. Thus, *H2a-H2d* are supported.

Technological construct, comprised of incompatibility (loading = 20.369, $p < 0.01$), complexity (loading = 20.576, $p < 0.01$) and economic cost of e-learning systems (loading = 20.483, $p < 0.01$), has a negative influence on the dependent variable. Thus, *H3a-H3c* are supported.

Table VI summarizes the results of the discriminant analysis.

Discussion and conclusions

With an increased number of hospitals considering adopting e-learning systems, this study aims to offer a more complete picture of factors contributing to the adoption

Variable	Wilks' λ	Loading	Not-adopting Mean	Not-adopting SD	Adopting Mean	Adopting SD
Management receptivity	20.017	0.436*	2.96	0.65	3.49	0.63
Management support	0.413	0.494*	2.81	0.86	3.54	0.72
Hospital size	0.112	0.572*	1.89	1.18	3.61	1.78
Specialization	0.300	0.623*	1.74	1.06	3.43	1.62
Functional differentiation	0.369	0.655*	1.34	0.43	1.90	0.46
Organizational culture-bureaucratic	20.211	0.303*	12.16	4.06	14.62	4.37
Organizational culture-innovative	20.220	0.360*	3.19	0.69	3.65	0.65
Incompatibility	0.389	20.369*	3.18	0.83	2.59	0.85
Complexity	20.431	20.576*	3.53	0.60	2.77	0.74
Cost	20.198	20.483*	3.65	0.72	2.93	0.81

Notes: *$p < 0.01$; Wilks' λ = 0.526 (χ^2 = 54.358; df = 12; p = 0.000)

Table VI.
Discriminant analysis

decision of e-learning systems in hospitals. A framework of factors that influence the adoption decision is proposed and empirically tested. The findings indicate that three constructs: managerial, organizational, and technological can collectively and individually influence the hospital's decision to adopt. Also, distinct characteristics of managerial, organizational, and technological variables exist between adopters and non-adopters. Managerial and organizational variables were all found to have a positive influence on the adoption decision, whereas technological variables were all found to have a negative influence on a hospital's decision to adopt.

The findings showed that top management's receptivity can significantly influence a hospital's decision to adopt e-learning systems. One way to enhance management receptivity is to expose management personnel to the technology and increase their understanding of it; these interventions should work since it has been found that a lack of knowledge about the adopted technology is a critical barrier for diffusion (Attewell, 1992). In addition, top management support was found to influence the adoption decision of e-learning systems. Strong top management support was indispensable for the successful implementation of an online learning and development system (Smethurst, 2006). Since e-learning is radically different from traditional methods of training hospital staff, there may inevitably be resistance to this new technology. In these situations, top management support would be crucial. Therefore, advocates of hospital e-learning systems should focus on educating top management on the benefits of such systems and on securing their support.

A novel result of this study is that specialized hospitals are more likely to adopt e-learning systems than general hospitals. This finding is likely due to the unique education and training requirements specialized programs have. To accommodate ongoing changes in internal medicine (including pressure to have more specializations), some hospitals are considering redesigning their residency education programs (Fitzgibbons *et al.*, 2006). To address these needs, e-learning systems can be considered as one of the solutions for education and training, not only in internal medicine specifically but also in the healthcare industry in general. For instance, the ability of e-learning systems to provide interactive, simulated and animated educational and training experiences (e.g. e-MRI.com) helps caregivers acquire knowledge of magnetic resonance imaging physics (Hoa *et al.*, 2006). It is conceivable that specialized e-learning systems can help specialists-in-training learn the basic, foundational knowledge on their own first, thus freeing up more time later for the senior specialists to transmit the harder-to-codify, tacit knowledge to the junior staff.

Another novel result of this study is that hospitals with a higher degree of functional differentiation are more likely to adopt e-learning systems. This finding makes sense because the cost of providing an overhead service such as training is likely high for those hospitals that have many administrative units, and in those situations e-learning represents an opportunity to more efficiently train staff scattered across many functions. In other words, e-learning programs accessed anytime anywhere can help improve learning efficiencies without the constraints of busy schedules and stretched resources.

Organizational culture was also found to be a significant determinant of the adoption decision of e-learning. In particular, hospitals with innovative culture (factor loading ¼ 0.360) were more likely than those with the bureaucratic culture

(factor loading ¼ 0.303) to adopt e-learning systems. In a hospital, bureaucratic culture usually entails operational inefficiency and poor quality care, whereas innovative culture can correct these problems and improve patient satisfaction (Meterko *et al.*, 2004). It is conceivable that hospitals with innovative culture are more likely to first experiment and eventually adopt e-learning systems for clinical or administrative training. Innovative culture is also a cornerstone of quality improvement initiatives of a hospital (Parker, 2000). This result confirms prior research which shows that, for project success, innovative culture has a stronger influence than bureaucratic culture (Rad, 2006).

Another important variable influencing the adoption decision of e-learning is hospital size. Although other studies have found a similar relationship showing that larger hospitals have increased chances of success when implementing technology and systems (Buciuniene *et al.*, 2006), our result specifically shows that hospital size also influences the decision to adopt e-learning systems. Our statistical evidence shows that the mean value (3.61) of hospitals adopting e-learning systems in this study is almost two times higher than that (1.89) of hospitals not adopting e-learning systems in the measure of hospital size. This indicates that hospital size is a strong predictive factor for the decision of a hospital to adopt e-learning systems.

Smaller hospitals have a higher pressure than larger hospitals to direct their limited financial and human resources to their core operations, that is, providing specialized medical care to patients. e-Learning systems, as part of IT investment, play a supporting role to the core operation in hospitals and other non-IT firms. It is very likely that small hospitals constrained with limited resources pay much less attention to the importance of e-learning systems than large hospitals. A study corroborating our findings shows that large hospitals (200 beds or more) have three to four times higher greater adoption rate than small hospitals (1-49 beds) (Furukawa *et al.*, 2008).

While this result implies that e-learning vendors should probably concentrate their marketing resources on larger hospitals, it is worrisome that as a result smaller hospitals may not learn as much about the latest e-learning technologies from vendors, and consequently, not reap the benefits of e-learning.

Technological factors including system complexity, incompatibility, and economic cost were found to be significant barriers to the decision to adopt. In actuality, these technological factors represent both intangible and tangible costs that a hospital must expend in order to adopt. While economic cost is a tangible cost, complexity is intangible in that hospitals perceive that skills required to implement are too complex and incorporating the system in their work practice is too difficult. Incompatibility is also an intangible charge because hospitals again perceive that additional work has to be done to ready the current IT infrastructure to operate with the new e-learning system. All three technological variables with the exception of tangible economic cost can be mitigated by moving e-learning platforms toward a standard-based, web-enabled, open architecture. For those hospitals that would like to avoid supporting their own client/server systems, complexity and incompatibility can be mitigated by subscribing to an e-learning service delivered over the internet. The migration toward this open learning architecture should facilitate the adoption decisions.

An increased number of hospitals are recognizing the importance of using e-learning systems to improve the quality of healthcare. Toronto' s Mount Sinai

Hospital adopted an e-learning system to enable physicians, residents, and nurses to gain medical knowledge using scenarios and apply them in the real-world clinical situations (Sanli, 2005). Many hospitals in Singapore are adopting e-learning systems to provide training in diagnostic radiology to caregivers, using a service managed by Singapore National Medical Image Resource Centre (Yang and Lim, 2006). The Freiburg University Hospital in Germany adopted an e-learning system to provide caregivers with a problem-oriented training in the domain of neuro-oncology (OncoCase) (Boeker *et al.*, 2005). Overall, it is likely that when managerial and organizational variables are leveraged and technological variables minimized, more hospitals will begin adopting e-learning systems to train their staff.

Limitations and suggestions for future research

This study investigated organization-level factors that were proposed to influence the adoption decision of e-learning systems in hospitals. The study targeted senior executives and managers of hospitals, thus their responses can adequately represent those at the organizational level. One limitation of this study is that for those hospitals that had already adopted e-learning systems, top management receptivity and support measured may not be their true attitude at the time of making the adoption decision. It is possible that senior executives and managers surveyed may be responding positively to those items *ex post* to justify their adoption decision. This limitation is common in cross-sectional adoption studies and has been acknowledged by others (Thong, 1999). A solution would be to use longitudinal studies to further investigate those antecedents previously identified in cross-sectional studies. Thus, future research may want to focus more on process-oriented, longitudinal studies that examine the process of adoption of e-learning systems. Also, the targeted hospitals were located in Taiwan, thus the results may not be generalizable to other hospitals located in other countries.

In addition, this study specifically examined organization-level variables in the context of hospitals. Hospitals are unique organizations, and admittedly, there may be other organization-level variables that are important for hospitals in the case of e-learning (e.g. existing in-house IT expertise). One organization-level factor that could conceivably be significant is the environment factor, which may include variables such as competitive pressure and regulatory landscape. Future theoretical work that incorporates additional variables in or modifies the proposed framework can further improve our understanding of how hospitals and staff adopt e-learning systems.

Furthermore, this study investigated direct relationships between independent variables and the dependent variable but did not examine possible interaction effects, thus future studies can certainly consider theoretically and empirically any interactions that may be present. Although we measured the interaction between hospital size and IT adoption decision, the influence of economic costs on hospital size or vice versa. The causal relationship is unclear. There may be an interaction between size and economic cost where smaller hospitals may be more sensitive to economic cost than larger hospitals.

Also, top management support may not matter too much in those hospitals that are highly specialized, since e-learning needs may be specialty-dependent and top management input in those situations may be less significant. Since hospitals are unique in that they have a dual authority or matrix structure, supports from both top

management and chief of practice may interact to produce a more powerful effect on the adoption decision. The matrix structure is a norm in the hospital environment and has resulted in the different levels of complexity of project execution (Burns, 1989). The influence of the matrix structure on the decision of adopting IT projects warrants further investigation. Overall, the proposed framework represents an important step and foundation upon which future studies can be based.

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