Extending Information System Models to the Health Care Context: An Empirical Study and Experience from Developing Countries

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Abstract: *This study aims to evaluate Hospital Information Systems (HIS) and their impact on end-user performance and the health care services in two developing countries. A survey methodology was used to gather empirical data for model validation and hypothesis testing. A correlation and factor analysis were conducted to test the reliability and validity of the study instrument. The structural equation modelling technique was also used to evaluate the measurement and the structural models. The results confirmed the significance of the integrated model in explaining user performance and demonstrated that our model can better represent factors associated with user performance and health care services; our model was able to explain 74% of the variance in user performance and 52% of the variance in the health care services. The study indicated the need to consider the context of the HIS when using models like the Technology Acceptance Model (TAM) and the information systems success model. Some information systems factors have become more relevant, such as System Quality (SQ) and Task-Technology Fit (TTF). Others have different implications, including ease of use and usefulness, indicating the need to adapt these models based on the context of the system under study.*

Keywords: *Health care informatics, hospital information systems, Technology Acceptance Mode (TAM), Perceived Usefulness (PU)*

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1. Introduction

Health care organizations strive to attract insured patients by providing the latest technology and advanced medical procedures [1]. It is widely accepted that the use of Information Systems (IS) in the health care sector provides great opportunities for improving the quality of healthcare services and the efficiency of the personnel [10]. If health care organizations do not adopt new and modern IS applications, they will become ineffective and lose the trust of their patients [3]. Consequently, health care organizations continue their quest for more efficient approaches of gathering patient data and meeting patient requirements and needs, placing increased demands on Information Technology (IT) applications.

The situation is also complicated by the segmented nature of health care data systems, as the information encapsulated in incompatible systems has inconsistent and perhaps uncoordinated definitions of formats and terms. Therefore, it is essential for different parts of organizations to have different data systems working together to improve quality of performance. This need has led health care organizations to make large investments in replacing old systems with new implementations in order to meet the need for precise and integrated information [4, 6, 12].

Health care stakeholders seem to be interested in assessing the outcomes of IS projects and implementations within their organizations. IS researchers on the other hand seem to be interested in analysing the level to which IS applications are meeting the varied needs of individual users in health care organizations [4]. It is worthwhile for researchers to test whether IS theories are applicable to complicated health environment systems. Fortunately, a number of theoretical frameworks and models are available for researchers in this endeavour to help provide useful diagnostic information, each with potential advantages and limitations [6].

The purpose of this study is to evaluate Hospital Information Systems (HIS) and their impact on end-user performance and on health care services in two developing countries. The study also aims to test the applicability and efficacy of IS models in the health care domain and to determine whether IS models provide a fitting theory for the health care context. This study also aims to evaluate end-user performance and the success of a health care enterprise system in hospitals, a system known as HIS.

2. Literature Review

In order to build a firm foundation for this study, we reviewed relevant literature on IS models, IS evaluation frameworks, and evaluation research on health care informatics. This helped to provide a theoretical basis for the key dimensions of the factors included in this study, to identify the strengths and limitations of each framework, if any, and to identify improvements in order to avoid weaknesses in the study model, as discussed below.

2.1. Technology Acceptance Model

The Technology Acceptance Model (TAM) was first introduced by [5] as an adaptation of the Theory of Reasoned Action (TRA), which proposed that user attitude toward IS was determined by Perceived Usefulness (PU) and Perceived Ease Of Use (PEOU) [21]. The TAM is a proven robust model with high predictive validity, and it denominates 10% of the space allocated to IS publications [10].

In health informatics, the TAM was applied, extended, and modified successfully [21, 22], proving its ability to explain important issues related to implemented technologies. For example, researchers used a modified TAM to investigate health professionals' usage of IT in hospitals [9, 20, 21]. The modified models explained a large portion of the variance in usage behavior, suggesting that the core constructs of the TAM have a significant effect on intended usage by hospital personnel. Even more recently, an ambitious effort to unify IT acceptance literature leading to the Unified Theory of Acceptance and Use of Technology (UTAUT), a theory with clear resemblance to the TAM [20]. The UTAUT integrates PU and PEOU into a performance expectancy construct. The UTAUT is a new and promising theory, with impressive explained variance for behavior and actual use of an information system [20, 21].

Many published studies on the TAM (or its extended/modified models) in health care address specific types of IT to explain technology acceptance among health institution personnel [2, 5, 11, 13]. Examples include physicians' use of microcomputers, physicians' acceptance of telemedicine application technology [7], pediatricians' adoption of internet-based health care applications, nurses' acceptance of bedside-computer applications [21], general practitioners' acceptance of decision support systems in primary health care, and success factors of inpatient patient-care IT [1].

Unfortunately, results from a many studies suggest that in some situation and or environments, the TAM model did not provide a complete understanding of the phenomenon investigated. A key limitation of the TAM is that the predictive efficacy of independent variables and/or the form of the relationship studied might vary systematically as a function of some other variable(s) might also vary. Despite the facts that the explanatory power of the TAM was/is validated by a large number of empirical studies, the TAM provides an explanation of user acceptance from a perspective of IT characteristics only rather than professionals or profession-specific groups. This may not explain medical and health professionals' perception of the HIS, because their characteristics might differ from typical technology users or general users. For example, medical doctors work autonomously, making it very difficult for hospital executives to force them to adopt a specific IS [10].

Overall, compared to other IS theories and models, the TAM has been the subject of a great deal of attention recently by health informatics researchers, and it has become an important theoretical tool for health IT research. The TAM is routinely recommended to aid activities like design and purchasing processes, training and informational sessions, and implementation [9]. Therefore, including the TAM in our model will improve our understanding of the effect of system features (interface and usefulness) on performance, and how the TAM variables (PU and PEOU) can lead to improved performance and service.

2.2. Task-Technology Fit Model

The Task-Technology Fit (TTF) model, developed by [8], is one of the most commonly used methodologies for studies assessing user evaluations of IS, and for understanding the linkage between IS and individual performance. The central premise of the TTF model is that "users will give evaluations based on the extent to which systems meet their needs and abilities" [8, 14]. The TTF emphasizes that IT is more likely to affect user performance and be used if the capabilities of the technology can match user tasks and performance requirements [8].

Although, some studies have highlighted the importance of the TTF model [14, 16], it is not fully recognized or utilized in health informatics. Only a small number of studies that utilized this model were found in the health informatics literature. This led to some bias and shortcomings in the previous studies, as the model is widely used in IS literature and has shaped significant progress in understanding IS in different settings, whether as one framework or in conjunction with other frameworks such as the TAM [5, 20].

Fornell *et al.* [7, 13, 19] used the TTF model and its instrument as tools to evaluate the implementation of the Electronic Medical Records (EMR) systems. Similarly, [19] adapted the TTF model to determine whether this model, along with individual characteristics, could have an impact on user evaluations of a health care system. They demonstrated the suitability of the model in the health care environment, where technology is the most complex factor of those used to determine user evaluations of a system.

Prior research demonstrated the usefulness of the TTF model as a diagnostic framework for evaluating implementation issues and the applicability of the TTF model in explaining the complexity of a the implementation aspects of health care information systems. Overall, the literature on IS models in the health area is lacking in systematic studies that investigate the TTF model, although the model has proved itself a valuable contributor to understanding IS impacts on user performance and user evaluation [8]. Factors including technology, task, and users are all necessary to evaluate the HIS [19, 20, 21], and thus the model was integrated into the current study model.

2.3. The IS Success Model

The IS success model is a multidimensional model that was pioneered DeLone and McLean [6] and is therefore often referred to as the Delone and McLean (D and M) IS success model. It has been widely utilized, validated, evaluated and extended in many IS studies [17, 18, 19], and has been updated by the inclusion of the service quality construct [6].

The determination of success depends on different factors such as the objectives, setting and the stakeholders of a system. Therefore, evaluation studies can explore if a specific system is successful in a particular setting [6]. Many attributes have been investigated in evaluations of health care IS including technical factors to outcome measures. Which criteria predict success is unclear, but it is likely that no single criterion can account for the success of IS [19]. This confirms the need to take a more incorporative view of the system and to cover several types of factors, such as technical, user, and system factors, as we do in this study.

The D and M model is rarely used in the health sector, so little is known about its potential in this complicated area. However, some noteworthy literature reviews [18, 20] have observed the need for more thorough evaluations of health care IS that look at a wide range of factors, including systems, technical factors, and organizational factors [5].

To date, no common evaluation framework has been identified specifically for health care information systems. Evaluation studies have used either some of the dimensions proposed by [6], or they have tailored their own characteristics according to the system being evaluated. However, studies that used D and M model showed its applicability to health care information systems. We therefore argue that using D and M model is essential to evaluating the HIS, and the original model constructs will operate in the same way in our model as they do in the original model.

2.4. Conclusion: IS Models in the Health Care Domain

Much has been written about end-user perceptions and evaluation of IS in different settings. Many theories that focus on user and system aspects have emerged in the literature, including TAM [19], TRA, D and M model [11], the Diffusion of Innovation Theory (DIT) and TTF model [13]. Of these, three IS models-the TAM, the TTF model, and D and M model-have been identified as relevant to this study for creating a more inclusive model.

Although, these models are well-recognized and frequently researched topics in the field of IS, and as much as 10% of the space allocated to IS publications is occupied by TAM research [9], little systematic research was conducted on these models in the health care context compared to other IS areas. Thus, a significant gap in knowledge exists [20, 23], indicating a need to develop and obtain an empirical support for the models within the health care context, and to undertake more replication studies to reinforce confidence in the good fit of IS models in the health care domain [1].

Recently, however, a growing number of publications of empirical studies utilizing different IS models, which have linked IS theory with advancement in health care technologies, have emerged in health informatics. Perhaps the most notable of these studies is the application of the TAM to the explanation and prediction of end-user reactions to health care IT [11, 23]. Recent meta-analysis of the state of research into IS models and frameworks in the health area is available in the literature [11].

Researchers expected that the use of IS across the health care industry will increase. The ability to identify, explore, predict, and manage individual usage of technology will help facilitate IT implementation efforts and increase the benefits gained by users, which is necessary for the ultimate success of IS [1, 16]. The need to assess the applicability of IS models in the health care industry is also linked with calls in the health care informatics research for improved knowledge and research on both information and telecommunication technologies among health care personnel [1].

To summarize, the IS models offer valuable evaluation frameworks that complement one another; they each evaluate different aspects of a system pertinent to human, technological and organizational factors. The models vary in terms of generality and specificity and theoretical underpinning. These frameworks do not, however, provide explicit evaluation categories for the evaluator. They can be combined into a single framework to enable more comprehensive evaluation of all important factors, and precise measures to facilitate HIS evaluation [3, 4].

3. Research Model and Hypotheses

3.1. Research Model

Effective evaluation of health care IS is essential in order to ensure that these systems efficiently encounter information processing needs and requirements of prospective users [1, 16]. To overcome the limitations of the models discussed above, the current study undertakes a critical review of prior research of the IS models, with particular emphasis on health care information systems. The aim of this review is to judge the efficacy of the models, to assess how these models account for the health care environment, and to determine what types of approaches have been used [8, 9]. As a result, a number of frameworks have been reviewed to combine a more coherent model, consisting of a set of factors that we deem necessary for the purposes of the current study, as illustrated in Figure 1. The synthesized model employs the key ideas of TAM, TTF model, and D & M model, as discussed in section 3.2.

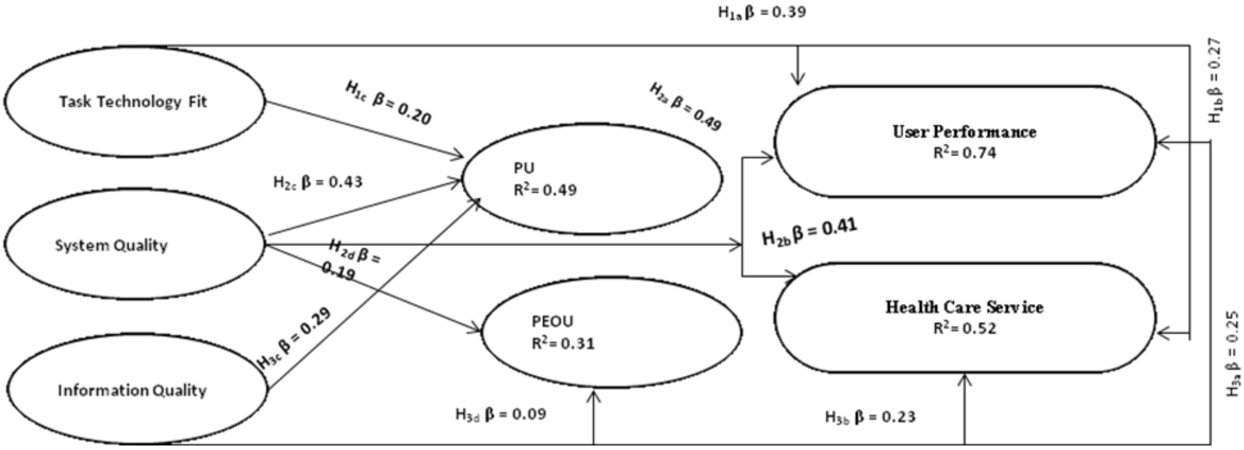

Figure 1. The study model.

3.2. Hypotheses

Our hypotheses have been directly derived from previous IS models. Research on TAM, TTF model, and D and M model validates many relationships in different IS settings proposed by this study. For example, TTF model served well to assess the effectiveness of a new system in helping users perform work-related tasks, and was found to be a good predictor of user performance [8, 13]. We hypothesized that when the system fits users' needs and task requirements, the users will perceive more system impact on their performance, and service improvement will occur. Hence, we put forwards the following hypotheses:

- *H1a*: TTF is positively associated with user performance.
- *H1b*: TTF is positively associated with health care service quality.
- *H1c*: TTF is positively associated with PU of the HIS.

Many studies on D and M model found that both System Quality (SQ) and Information Quality (IQ) affect individual impacts "user performance" [17]. SQ was found to be a main factor affecting individual work and task performance directly and indirectly through other factors [8, 9, 21]. We hypothesized that the higher the users' perception of SQ is, the more useful it is and the better the perceived performance. This subsequently leads to better health care service.

- $H2_a$: SQ is positively associated with user performance.
- $H2_b$: SQ is positively associated with health care service quality.
- $H2_c$: SQ is positively associated with PU of the HIS.
- $H2_d$: SQ is positively associated with PEOU of the HIS.

Prior research found that high information content (complete, accurate, and relevant information) leads to better performance and a greater impact on individual and organizational outputs [6]. We posit that the higher the information quality, the more the users will perceive usefulness and performance impacts. This, in turn, leads to better health care service. Taking into account the above-mentioned research, we put forward a set of hypotheses as follows:

- $H3_a$: IQ is positively associated with user performance.
- $H3_b$: IQ is positively associated with health care service quality.
- $H3_c$: IQ is positively associated with PU of the HIS.
- $H3_d$: IQ is positively associated with PEOU of the HIS.

4. Methodology

4.1. Instrument, Procedure and Sample

A survey methodology was used to gather empirical data for instrument validation and hypothesis testing. The study instrument (questionnaire) was constructed based on an extensive review of the literature in the areas of IS and health informatics.

The key TAM constructs investigated (PU and PEOU) were measured using questions adapted from the original instrument developed by [5], while key constructs in the TTF model, task, and technology characteristics were measured using items adopted from the original TTF questionnaire [8]. Similarly, the D and M constructs of SQ, IQ, and service quality were measured using items adopted from the updated instrument of [6]. All measurement items (when needed) were tailored to fit the context of the HISs under investigation [19].

The questionnaire was pre-tested with several experienced users to increase the face validity and was modified according to their feedback. Other than changes in wording to fit the HIS studied, no significant changes were made to most factors. The study was conducted in seven hospitals that had implemented the HIS more than three years ago in both Saudi Arabia and United Arab of Emirates. A total of 213 questionnaires were gathered from the seven hospitals. After eliminating the incomplete questionnaires, 197 valid questionnaires remained. The sample was almost equally split between males (53%) and females (47%). The participants had used the systems in question for an average of 3.7 years. The participants represented a varied range of positions within the organizations, including nurses, doctors, administrative staff, and clinical professionals, as summarized in Table 1.

Table 1. Demographics of the sample (N=197).

Factor	Classification	Frequency	Percentage
Gender	Male Female	104 93	52.8% 47.2%
Education	Vocational Bachelor Postgraduate	11 166 20	5.6% 84.3% 10.1%
Work Type	Medical/Doctor Nursing Administrative Others	97 52 21 27	49.2% 26.4% 10.7% 13.7%
Experience with the HIS	1-3 years 4-6 years 7-10 years > 10 years	63 127 7 0	32% 64.5% 3.5% 0.0%

4.2. Reliability and Validity

Both reliability and validity of the instrument were assessed Tables 2 and 3. Reliability was examined through the determination of Cronbach's coefficient alpha (β). The reliability test indicated the presence of satisfactory Cronbach alpha scores, which ranged from 0.81 for the SQ to 0.93 for the PU, demonstrating high reliability [15].

The construct validity was assessed by conducting both Discriminant and convergent validity tests [15]. Discriminant validity can be assessed using the square root of the Average Variance Extracted (AVE) for each factor; the factors are different if the AVE for the factors is greater than their shared variance [7, 15].

Table 2. Correlations of constructs and average variance extracted.

Factors	AVE	TTF	SQ	IQ	PU	PEOU	UP	HS	Alphaα
TTF	0.89	(0.94)							0.84
IQ	0.83	0.78	(0.91)						0.87
SQ	0.87	0.63	0.59	(0.93)					0.81
PU	0.78	0.59	0.55	0.67	(0.88)				0.93
PEOU	0.90	0.67	0.49	0.56	0.52	(0.95)			0.89
UP	0.89	0.52	0.39	0.47	0.39	0.45	(0.94)		0.85
HS	0.72	0.48	0.29	0.59	0.28	0.71	0.41	(0.85)	0.82
Numbers in parentheses are the square roots of the AVE.									

Table 3. Goodness-of-fit for both the measurement and structural models.

Criteria/Indices	Recommended Value	Measurement Model	Structural Model
Chi-square (χ2)	- - -	307.67	301.10
Degree of Freedom	- - -	192	195
χ2/df	>2	1.60	1.54
GFI	>0.90	0.94	0.93
NFI	>0.90	0.91	0.92
NNFI	>0.90	0.93	0.93
CFI	>0.90	0.92	0.92
RMSEA	>0.08	0.81	0.81

The Results reported in Table 2 demonstrated that Discriminant validity was achieved. The diagonal values in parentheses represent the square root of the AVE. All AVE values are greater than the off-diagonal values (shared variance) in the corresponding rows and columns.

Convergent validity is often recommended when the load of measurement items is 0.70 or greater [21], while the AVE scores of all factors must exceed the threshold value of 0.50, as suggested by [7]. All factor loadings for this study exceeded the recommended value of 0.70, and the AVE values ranged from 0.72 to 0.90, indicating that convergent validity was satisfied.

5. Analysis and Findings

5.1. Tests of the Measurement Model

Before testing the hypotheses in an appropriate model, we checked the goodness of fit of the research model. The fit between the data and proposed measurement model was measured using a chi-square Goodness-of-Fit Index model (GFI). Criteria that researchers often use are a GFI index exceeding 0.80, and indices of Normed Fit Index (NFI) and Incremental Fit Index (IFI) exceeding 0.90 for acceptable model fitness. The recommended fit values for the GFI should be more than 0.90, and the Adjusted Goodness-of-Fit Index model (AGFI) should be more than 0.80 [7, 15]. In general, if the value of χ^2/df is smaller than 5, it is considered a good fit. Conversely, a Root Mean Square Error of Approximation (RMSEA) of less than 0.08 suggests a good fit.

All the goodness-of-fit measures fall into acceptable ranges, with scaled X^2 /df=1.60, CFI= 0.92, GFI=0.94, NFI=0.91, and RMSEA=0.081, as listed in Table 4. The evidence indicates that the proposed combined model provided a good fit with the data.

Table 4. Results of hypotheses tests (path coefficients): direct and indirect effects.

Hypothesis	Path Coefficient β	t-Value	Support
H1a TTF→ User performance	0.39	6.85	Yes
H1b TTF→ Health care service	0.27	3.55	Yes
H1c TTF→ PU	0.20	2.81	Yes
H2a SQ→ User performance	0.49	6.39	Yes
H2b SQ→ Health care service	0.41	3.07	Yes
H2c SQ→ PU	0.43	4.87	Yes
H2d SQ→ PEOU	0.19	2.89	Yes
H3a IQ→ User performance	0.25	4.50	Yes
H3b IQ→ Health care service	0.23	3.48	Yes
H3c IQ→ PU	0.29	2.08	Yes
H3d IQ→ PEOU	0.09	1.70	No
Overall, HIS → User performance	0.74	11.09	Yes
Overall, HI S → Health care service	0.52	8.09	Yes

5.2. Tests of the Structural Model

The synthesized structural model was tested using structural equation modelling, and the relationships between all factors were tested using path coefficients and t-test analyses. The findings of the structural model for measures of fitness are shown in the fourth column of Table 4 to facilitate comparison of the validity results. Like those reported for the measurement model in the third column, the goodness-of-fit indices for the structural model were X2/df=1.54, CFI=0.93, GFI=0.93, NFI=0.92, and RMSEA=0.81. Thus, the integrated model provided a good fit with the data in the HIS environment. Most of our hypotheses were supported, and the paths between all of the factors were found to have significant and positive relationships. The hypotheses, path coefficients (β), and t-values for all of the factors are summarized in Table 4 P<0.05. The findings indicated that the TTF model significantly affects user performance and health care service (β=0.39, t=6.85, β=0.27, t=3.55). This means that when the HIS has the right fit with user needs and task requirements, users tend to perceive more benefits and more impacts on their user performance. This leads to a better health service for patients in terms of time taken to serve them, service quality, and fewer mistakes; H1a and H1b are thus supported. SQ was the most powerful factor directly affecting user performance and health care service β=0.49, t=6.39 and β=0.41, t=3.07, p<0.05). Hence, H2a and H2b are supported.

In relation to IQ, the findings revealed significant positive effects of IQ on user performance and health care service (β=0.25, t=4.50 and β=0.23, t=3.48, p<0.05); H3a and H3b are thus supported. Surprisingly, no significant effect for IQ on PEOU was observed, and thus H3d (IQ-PEOU) was rejected. However, all of the factors discussed above had significant and relatively different effects on both PU and PEOU. Specifically, TTF significantly affected PU (β=0.20, t=2.81, p<0.05), and H1c is thus supported. Similarly, SQ had significant effects on PU and PEOU (β=0.43, t=4.87, β=0.19, t=2.89, p<0.05), supporting the H2c and H2d hypotheses.

Overall, the HIS affects user performance in health care organizations and helps users perceive positive impacts on performance and improved health care service. Our model has demonstrated significant predictive power in explaining a large and substantial part of the variance of both user performance (β=0.74) and the health care service (β=0.52). These results indicate that the greater the TTF, SQ, and IQ of HIS that users perceive, the better the performance and the health care service will be.

6. Discussion, Conclusions and Implications

In this research, we argued that IS models can contribute to the further development of health informatics knowledge by bringing awareness and research attention to user and system factors of health information systems. The study highlighted that user evaluation of the HIS is a complex and multidimensional task that requires a profound understanding of several elements including system, user, technology, and other relevant elements from multiple perspectives. Therefore, a successful evaluation should explicitly define the studied variables and propose a framework for dimensions and factors involved in user evaluation linking existing studies to that framework. This research offers conceptual and practical contributions to understanding how the HIS affects performance and improves health care services by extending and advancing the IS theories to the health context. The current study demonstrated that there are a still opportunity for researchers to enhance IS models and their capabilities as useful theoretical tools in health care informatics.

The results confirmed the significance of the integrated model in explaining user performance, and demonstrated that the study model can better represent factors associated with user performance and health care service. As in other studies reported in the literature, the core factors of D and M and the TAM (PU, PEOU, SQ, and IQ) were found to have a strong influence on both user performance and health care services. For example, we found that SQ plays a critical role in affecting user performance and leads to improved health care services. The structure equation analysis results showed that ten of the eleven initial hypotheses were supported.

The original TAM relationships were confirmed. The findings showed the significance of PU and PEOU in utilization and impacts on performance and health care services. However, in the health care context, evidence existed for a stronger dependence by HIS users on utility than on lower complexity when adopting the HIS. The results indicated that both correlations and path coefficients were higher for relationships with PU than those with POEU. Prior research has investigated this issue and failed to find any direct post-implementation effects of PEOU; effects have only been found in pre-implementation [13]. This implies that as users gain experience with the HIS, PEOU may be overshadowed by other factors.

This study confirmed the relationship between the TTF and TAM models through the effect of the TAM on PU, which has not been adequately explained in prior research and perhaps less still in HIS literature. The effect of TTF model on PU signifies that system users establish their beliefs regarding whether the technology is helpful in completing their tasks from the evaluation of technology characteristics, rather than from an indirect influence through PEOU. Thus, the role of TTF in determining users' evaluation of the system benefits is more important than our expectations. Hospitals and HIS vendors must enhance system benefits. The higher PU would encourage users to have a more positive attitude and perceived impacts. Therefore, the HIS must be designed to be more user-friendly systems. If users can use the system effectively, and they find it helpful in enabling them to perform tasks efficiently, they then develop a better attitude toward it and will perceive its impacts to be greater; thus, more service improvements will occur.

The fit between task requirements, user needs, and HIS results in more system impacts and health service improvements. However, some researchers found that PEOU, but not PU, was affected by TTF [13]. In contrast, other researchers found that TTF can result in higher PU. The inconsistent results of the previous studies and of the present study indicate that the relationships among TTF and PU and PEOU are worthy of further investigation. Fortunately, the results of the various TTF measures have been found useful for diagnostic purposes. For example, the TTF measures where the new system appeared to best meet user needs were related to completeness, presentation, system availability, and reliability.

The paths from SQ and IQ to user performance emerged as hypothesized by the original model. However, the path from SQ was stronger than the path from IQ. As indicated in prior research, SQ was the most important factor affecting both user performance and health care service [11]. Interestingly, however, the links between the D and M model and the TAM showed a unique relationship. SQ was found to be a significant factor affecting both PU (β=0.43) and PEOU (β=0.19). IQ affected only PU, but no significant relationship was found between IQ and PEOU. This might be explained by the nature of the work and information needs of the hospital personnel, as they may be more concerned about the accuracy and completeness of the information than the ease of accessing the information.

This study indicates that it is extremely important to consider the context of the HIS when using frameworks such as the TAM and D and M models to assess the system. Some IS factors, such as SQ, become more relevant in the HIS context, and other factors, such as PEOU, have quite different implications. Above all, this study not only demonstrates the value of using IS models to evaluate HIS, but also suggests a need to adapt such models based on the context of the system under study.

From a practical standpoint, the study findings provide HIS practitioners with useful insights on the factors that drive system utilization, usefulness, and impacts health care services. Accordingly, HIS designers and health care organizations are well advised to increase the usefulness of their systems by enhancing the main features of the system and, if possible, developing additional features that user could perceive as useful, such as integration capabilities and responsiveness of the HIS. Furthermore, since SQ dimensions have a strong impact on PU, careful consideration must be given to develop systematic ways of improving system design that has greater PU and positive impacts on user performance and the quality of the health care service. For example, such improvements can be made by enhancing the HIS user interface and output formatting.

In conclusion, the study provides some insights to help HIS practitioners know more about the IS aspects that help improve the HIS utilization and benefits, and they can prioritize their investments accordingly. Our contribution to IS theory is the combination and further empirical testing of the IS models in a different and very complicated context. This study is among the first to empirically validate a more comprehensive IS model. The results of this study revealed that the dimensions of one model alone are not adequate to fully capture the factors for evaluating or manipulating a system. Incorporating other models, more factors, or both seems necessary to fully understanding the phenomena under investigation in the health care context.

Finally, although this study offers some insights into the evaluation and impact of HISs on medical personnel performance, it still has some limitations. The study did not test the relationship between PU and PEOU, as we think the relationship was adequately addressed in previous studies. However, this relationship may well mediate or moderate the effect HIS on the dependent factors. Moreover, inconsistent results for the relationships between TTF and PU and PEOU are worth further investigation. Lastly, further research replicating the study model with a different group of clinical and/or health professionals may bring a new insight and help to explain the remaining unexplained variance in user performance and health care service.

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