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A R T I C L E

Factors Determining Nurse Acceptance of Hospital Information Systems

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Recently, integrated health information technologies (HITs) have played an important role in the management of healthcare institutions, potentially improving the quality of care and services provided for patients.^{1,2} Approximately 95% of Taiwanese hospitals have already implemented computerized physician order entry systems, a major element of hospital information systems (HISs), to assist physicians in their clinical activities. Nursing staff are the major care providers, comprising the largest group of workers in any hospital. They represent “key collectors, generators, and users of patient/client information” in healthcare management.^{2(p2)} Currently, healthcare is dominated by a multidisciplinary approach, in which various healthcare professionals work together to provide comprehensive, coordinated care. The implementation of HISs can help nurses to manage a wide range of complex data and improve the quality of healthcare by improving the efficiency and effectiveness with which they perform their daily tasks.³ Prior studies have suggested that the acceptance of technology can be viewed as a surrogate for measuring the success of information systems, indicating that the acceptance of nursing staff is essential to the successful adoption and implementation of HISs.⁴

In using an HIS, nurses may experience both benefits and challenges. Their experience using an HIS is further influenced by differences in the background of nursing staff, information literacy, and various factors associated with their specific organization.^{5,6} Because of poor information literacy and a lack of information technology (IT) management knowledge among nursing practi-

tioners in Taiwan, the means by which to support nursing care is discussed only in the development stage

This study proposed an evaluation model, derived from the Technology Acceptance Model and Information System Success Model, to explore factors influencing the acceptance of hospital information systems by nurses. Although many healthcare institutions have applied hospital information systems, relatively few studies have investigated the perceptions of nurses regarding the usefulness, ease of use, or acceptance of these systems. This study recruited the nursing staff of a regional hospital in Taiwan. A total of 297 questionnaires were sent, and 277 were returned, for a response rate of 93.3%. The results indicated that system quality, information quality, and service quality were positively correlated with the perceived ease of use ($R^2 = 0.69$) and perceived usefulness ($R^2 = 0.72$). Information quality has the greatest influence on perceived usefulness ($\gamma_3 = 0.57$, $P < .001$) and ease of use ($\gamma_4 = 0.61$, $P < .001$). Perceived usefulness and ease of use have a significant influence on system acceptance ($R^2 = 0.75$). Perceived usefulness ($\beta_1 = 0.61$, $P < .001$) has a significant influence on system acceptance. These findings indicated that nursing care requires high-quality healthcare information to support the daily activities of nursing professionals. The results of this study also provide a valuable reference for hospital administrators in developing hospital information systems.

KEY WORDS

Hospital information systems • Nurse • User acceptance • Structure equation modeling

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of HIS implementation. Furthermore, most previous empirical studies have focused on the acceptance of HISs from the perspective of physicians, with few studies investigating this issue from the viewpoint of nurses. In addition, the implementation of an HIS requires a thorough evaluation of technological options and issues related to the organization and the individuals involved.⁷ This study proposes an integrated framework, combining the constructs of the Technology Acceptance Model (TAM) and the Information System Success Model (ISSM)^{8,9} to identify the factors influencing the acceptance of HISs by nurses.

LITERATURE REVIEW

Hospital Information Systems and Nursing Professionals

Modern healthcare organizations depend heavily on collecting a wide range of accurate information and sharing among individuals throughout the organization.¹⁰ Many studies have described the benefits of implementing HISs and HITs, and for many years, hospitals in Taiwan have been turning to this technology to support hospital administration, education, medical care, and services and improve medical decision-making capabilities. The evolution of HISs has shifted the focus from functional and administrative efficiency to professional and patient-related issues. The development of new technologies, such as electronic medical record and mobile technologies, has had a huge impact on HISs in supporting the efforts of a wide variety of professional personnel. Clearly, the support offered by HISs needs to be carefully evaluated from the perspective of multiple healthcare professionals.

Researchers have pointed out the urgent need for a more thorough evaluation of patient care information systems.¹¹ Nurses are important users of HISs in hospitals—generating, collecting, and ultimately using patient/client information.² Many information systems currently established in healthcare organizations are poorly integrated with nursing activities, requiring nursing staff to spend additional time searching for information instead of attending to their patients.¹⁰ Several factors, including insufficient integration within nursing workflow,⁵ poor-quality patient data,⁵ a lack of systems using nursing terminology,¹² and poor assimilation of information systems in the nursing workflow,⁶ have been identified as possible factors related to the failure of HISs to provide adequate support for nursing activities.

The delivery of nursing care has always depended on the quality of information available to nurses.² High-quality patient-centric data provided by an HIS can assist

nurses in making clinical decision, by making available patient health information at the point of care. Although the appropriate use of HISs can help nursing staff to improve the efficiency and effectiveness of their efforts, the implementation of HISs seldom benefits the process of nursing, because of a failure to meet the requirements of nurses. Two possible reasons may be that (1) integrating HISs into daily nursing activities involves more than just technology, including factors such as education, changing attitudes, culture, standardized documentation, and healthcare practices,⁴ and (2) insufficient user acceptance has long been an obstacle to the successful adoption of IT/Information Systems (IS),¹³ particularly in the context of healthcare. Nursing staff make up the largest group of workers in any hospital; therefore, the perspective of nurses is crucial to the success of HISs, particularly in its adoption, implementation, and development. In addressing the poor evaluation of HISs, this study investigates factors crucial to the acceptance of HISs from the perspective of nursing. The results of this study provide a complementary perspective for the evaluation of HISs, minimizing the gap in perceptions between physicians and nurses with regard to the use of HISs.

Technology Acceptance Model

The TAM is based on the Theory of Reasoned Action,¹⁴ as is the Theory of Planned Behavior.¹⁵ Theory of Reasoned Action and Theory of Planned Behavior suggest that individual beliefs determine individual attitudes. Attitude (A) represents a perceived behavioral control, which introduces behavioral intention, resulting in actual behavior. The postulates that computer usage is determined by behavior intentions; a person's acceptance of IS/IT is believed to be determined by his/her intention to accept IS/IT.¹⁶ The TAM also suggests that two beliefs—perceived usefulness (PU) and perceived ease of use (PEOU)—explain variance in user intentions. The PU represents the degree to which a person believes that using a particular system will enhance his/her job performance.⁸ The PEOU is the degree to which a person believes that using a particular system will be effortless.⁸ Perceived usefulness and PEOU enable managers to understand the acceptance of IS/IT by users. The results of previous studies in healthcare settings have provided substantial empirical support for TAM.^{17,18}

Information Systems Success Model

The major reason for adopting the ISSM as the theoretical foundation in this study lies in its comprehensive and specific categories of evaluation, proven validity, and applicability in the evaluation of HISs.⁹ A review of the determinants of success of inpatient clinical IS indicates

that the categories related to success in information systems can also be applied to the assessment of HISs.¹¹ This study proposes and tests a research model based on the ISSM by DeLone and McLean.^{9,19} The model comprises six categories or dimensions of success, which are causally and temporally linked by the fact that success is a dynamic process rather than a static state. The multidimensional relationships between these measures of the success of information systems have been extensively tested in studies on healthcare IS/IT.^{9,19} Based on these studies, DeLone and McLean^{9,19} updated the model to include six system dimensions: (1) system quality, measuring the information processing system itself (eg, usability, accessibility, and ease of use); (2) information quality, measuring the information output (eg, accuracy, completeness, legibility); (3) service quality, measuring information systems technical support or service; (4) intention to use, use referring to one's intention to use a system or actually use it; (5) user satisfaction, representing the response of recipients to the use of the information system output; and (6) net benefits, measuring the overall positive and negative impact of an information system.

Theoretical Background, Model, and Hypotheses

In this study, we propose a research model comprising six constructs of system quality, information quality, service quality, PU, PEOU, and system acceptance based on the theoretical foundation of ISSM and TAM. This model is suitable for nursing personnel, representing the major users of an HIS.² The degree to which nurses perceive the quality of an HIS has a significant effect on the evaluation of the system. In this model, the first three constructs are quality antecedents of ISSM: system quality (the inherent features of HISs including system performance and user interface), information quality (completeness, accuracy, timeliness, relevance, legibility, and consistency or reliability of the patients' information and reports produced by the system), and service quality (the overall support delivered by the service providers of HISs or technology). Previous studies have incorporated the three quality antecedents of ISSM as the external factors of TAM.²⁰ On the other hand, the other three constructs of PU (the advantages of utilizing HISs for job performance of medical practice), PEOU (the degree to which users believe that adopting HISs is free from effort), and system acceptance (the attitudes of nurses toward using HISs) are the core of most IT/IS technology acceptance studies. Technology Acceptance Model suggests that PEOU and PU in IT/IS determine the attitudes of individuals with regard to IT/IS.⁸ Users with more positive attitudes toward IT/IS are more likely to be satisfied with the system and, in turn, view

it as more useful.^{21,22} According to the results of previous findings, this study hypothesizes the following:

1. H₁: System quality is positively associated with the perceptions of nurses regarding the usefulness of HISs.
2. H₂: System quality is positively associated with the perceptions of nurses regarding the ease of using HISs.
3. H₃: Information quality is positively associated with the perceptions of nurses regarding the usefulness of HISs.
4. H₄: Information quality is positively associated with the perceptions of nurses regarding the ease of using HISs.
5. H₅: Service quality is positively associated with the perceptions of nurses regarding the usefulness of HISs.
6. H₆: Service quality is positively associated with the perceptions of nurses regarding the ease of using HISs.
7. H₇: Perceived usefulness is positively associated with nurse acceptance of HISs.
8. H₈: Perceived ease of use is positively associated with nurse acceptance of HISs.

Figure 1 encapsulates the hypothesized relationships from the research model.

METHODS

Design

This quantitative research uses a cross-sectional study to explore factors influencing the acceptance of HISs by nurses. The survey recruited subjects of nursing personnel with more than 6-month experience using HISs in a regional hospital in Taiwan. The initial questionnaire was derived from the results of literature reviews and revised by an expert panel, comprising experts in the field of healthcare, nursing, and the management of information systems. Structural Equation Modeling (SEM) was used for data analysis to examine the degree of causality between model variables.

Power Analysis

The power of this study was based on MacCallum et al,^{23,24} and Kim²⁵ proposed methods to calculate the required sample size or the achieved power to assess the fit of SEM based on different fit indices (eg, root mean square error of approximation [RMSEA]).^{23–25} The required sample was 45, and this number achieved 80% power at a 5% level of significance, and degree of freedom was 1162.²⁵

Sample and Setting

We collected empirical data targeting nursing staff with more than 6 months of experience using HISs.

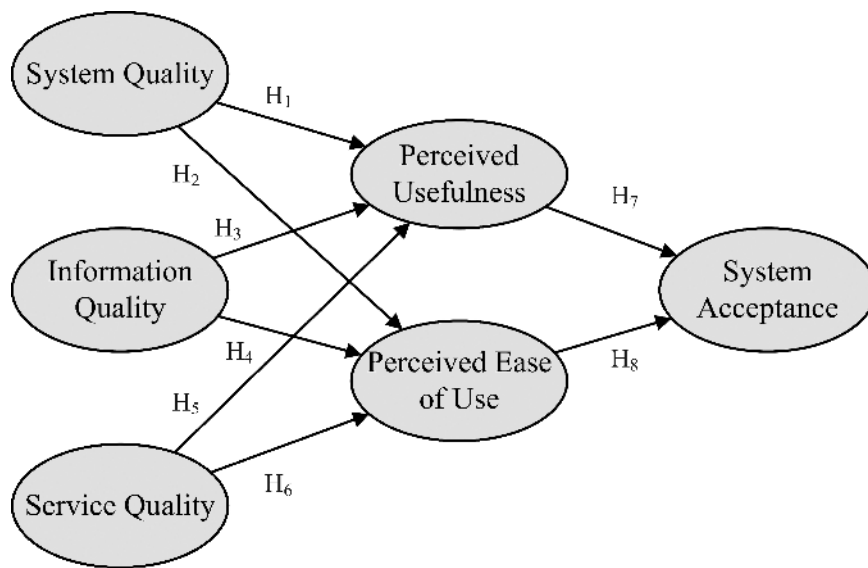


FIGURE 1. Research model.

The case hospital was a public facility with 450 beds established more than 40 years previously. The case hospital was one of the first institutions in Taiwan to adopt HISs, following the introduction of National Health Insurance Bureau. The HISs of the case hospital covered inpatient information systems, outpatient information systems, emergency information systems, and hospital administrative information systems, with 42 subsystems to support medical services and the associated administration. Following the widespread use of the Internet and related technology, the hospital has implemented e-hospital and electronic procurement systems to provide user-friendly medical consultation services and reduce operational costs. In 2008, the hospital established a full-scale picture archiving and communication system to provide better clinical diagnostic services and improve patient satisfaction. At present, the hospital is planning the introduction of mobile healthcare applications using radiofrequency identification technology to enhance patient safety and the quality of care. For these reasons, this hospital was selected as the case hospital in this study.

Data Collection

We conducted a pilot test of the revised questionnaire using 10 nurses to remedy semantic misunderstanding prior to distribution to all nurses. The study was approved by the institutional review board of the case hospital. The survey was distributed to 297 respondents, and 277 responses were returned, for a response rate of 93.3%. Voluntary participation might explain the relatively high response rate. The survey instrument was divided into two major parts. The first part in-

cluded the demographic information of the respondent, such as sex, age, education level, and experience using computers and HISs; the second part contained questions regarding the six constructs in the investigation model. Each construct was measured using multi-item questions derived from a review of previous studies, and each item was answered using a five-point Likert scale (one indicating “strongly disagree” and five indicating “strongly agree”). The constructs of the theoretical model and its operational definition, source, and measurement items are shown in Table 1.

Data Analysis

First, LISREL 8.3 (Scientific Software International, Inc, Lincolnwood, IL) and SPSS 13.0 (SPSS Inc, Chicago, IL) were used for statistical analysis in this study. The analysis of SEM included the analysis of the measurement model and structural model analysis. First, measurement model analysis included empirical parameters to examine whether all measured variables accurately reflected the potential research constructs in the measurement model. The reliability of this study was determined using Cronbach α and composite reliability, while construct validity was measured using convergent validity and discriminate validity. Discriminant validity indicates the extent to which a given concept differs from other constructs.³³

Second, structural model analysis was used to examine the global fitness of observed data to the research model and the dependencies and correlations among all potential variables. Nine model-fit measures were used to assess the overall goodness of fit: ratio of χ^2 to degrees of freedom (df), goodness-of-fit index (GFI), parsimony GFI (PGFI), normalized fit index (NFI), nonnormalized

Table 1**Measurement and Operational Definitions of Variables**

Construct	Operational Definition	Source	No. of items
System quality	The inherent features of HISs including system performance and user interface	Etezadi-Amoli and Farhoomand ²⁶ ; Wixom and Todd ²⁷ ; Yusof et al ⁷	7
Information quality	Completeness, accuracy, timeliness, relevance, legibility, and consistency or reliability of the patients' information and reports produced by the system	Doll and Torkzadeh ²⁸ ; Otieno et al ²⁹ ; Yusof et al ⁷	11
Service quality	The overall support delivered by the service providers of HISs or technology, regardless of whether the service is delivered by the internal department of healthcare organization or outsourced to external providers	Kettinger and Lee ³⁰ ; Yusof et al ⁷	8
Perceived Ease of Use	The degree to which users believe that adopting HISs is free from effort	Davis ⁸ ; Etezadi-Amoli and Farhoomand ²⁶ ; Wixom and Todd ²⁷	5
Perceived Usefulness	The advantages of utilizing HISs for job performance of medical practice and future as subjectively believed by users	Davis ⁸ ; Wakefield et al ³¹	12
HIS acceptance	The attitudes of physicians toward using HISs	Schectman et al ³² ; Wixom and Todd ²⁷	2

fit index (NNFI), comparative fit index (CFI), RMSEA, root mean square residual (RMR), and standardized RMR (SRMR).

15.2% in general surgery division, 13.4% in psychiatry division, and 12.6% in the ICU.

Measurement Model

The model comprised six latent constructs with a total of 54 items. The results of Cronbach α , construct reliability, convergent validity, and discriminant validity are shown in Table 2. Hair et al³⁴ suggested that Cronbach α should exceed .7. As shown in Table 2, the value of Cronbach α of all constructs was greater than .9, indicating high reliability. In addition, the internal consistency of the measurement model was assessed by computing the composite reliability of the constructs ranging between .8 and .9, exceeding the recommended cutoff level of .7.³⁵ Furthermore, the construct validity of this study was assessed using convergent validity and discriminant validity. Fornell and Larcker³⁶ proposed that the average variance extracted (AVE) value should exceed 0.5 and be greater than each square correlation,

RESULTS

Demographic Data

Most nurses in Taiwan are female, and not surprisingly, 273 of the respondents (98.6%) to this questionnaire were female. The most common qualification title was professional nurse (73.3%). The age range of participants was 20 to 65 years. Most respondents (71.5%) were younger than 30 years, and most respondents (74.7%) had college degrees. Moreover, the largest percentage of respondents (44.0%) had between 1 and 3 years of HIS experience. Moreover, 95.7% of respondents had over 1 year of IT experience. Furthermore, 32.1% of the respondents were working in general medicine division,

Table 2**Cronbach α , Construct Reliability (CR), Convergent Validity, and Discriminant Validity**

Factors	Cronbach α	CR	AVE	Factor Correlations					
				SQ	IQ	SerQ	PEOU	PU	A
SQ	.90	0.80	0.74	0.86 ^a					
IQ	.98	0.86	0.81	0.56	0.90				
SerQ	.98	0.86	0.83	0.53	0.59	0.91			
PEOU	.95	0.85	0.78	0.43	0.47	0.50	0.88		
PU	.98	0.90	0.80	0.51	0.53	0.52	0.43	0.89	
A	.95	0.81	0.87	0.49	0.47	0.46	0.38	0.43	0.93

Abbreviations: A, acceptance; IQ, information quality; PEOU, perceived ease of use; PU, perceived usefulness; SerQ, service quality; SQ, system quality.

^aThe shaded numbers in the diagonal row are square roots of the AVE. Off-diagonal elements are the correlations among constructs.

suggesting adequate convergent validity and discriminate validity. Table 2 shows that the AVE of the measurements ranged between 0.74 and 0.87, which exceeded the recommended value ($AVE > 0.5$), indicating excellent convergent validity. One criterion for adequate discriminant validity is that the square root of the AVE for each construct exceeded the correlation between the construct and other constructs in the research model.³⁶ Our study found that all AVEs were greater than the off-diagonal elements in corresponding rows and columns, demonstrating good discriminant validity. As shown, our study had adequate reliability, convergent validity, and discriminant validity.

Structural Model

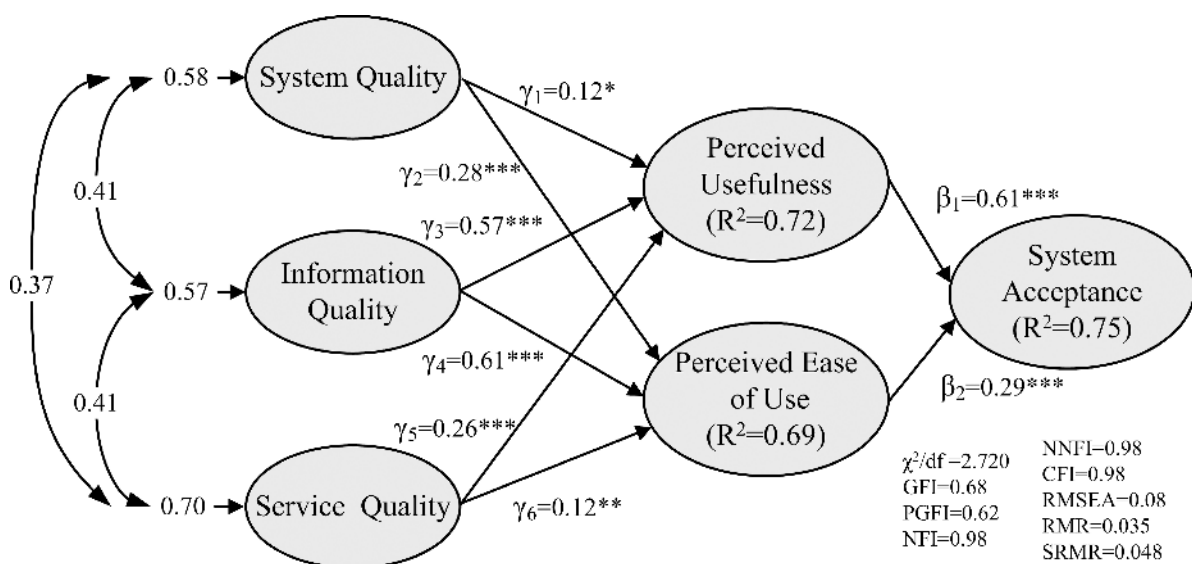
This study examined the path coefficients of the structural model. In the following path coefficients, γ denotes the structural coefficients relating the latent-independent variable to the latent-dependent variable. Figure 2 presents the significant structural relationships between the research variables and the standardized path coefficients. These results imply that system quality has a positive influence on PU ($\gamma_1 = 0.12$, $P < .01$) and PEOU ($\gamma_2 = 0.28$, $P < .001$), supporting both H₁ and H₂. The data also show that information quality positively influences both PU ($\gamma_3 = 0.57$, $P < .001$) and PEOU ($\gamma_4 = 0.61$, $P < .001$), supporting H₃ and H₄. Furthermore, service quality positively influences both PU ($\gamma_5 = 0.26$, $P < .001$) and PEOU ($\gamma_6 = 0.12$, $P < .01$), supporting H₅ and H₆. Finally, system acceptance is influenced by PU ($\beta_1 = 0.61$, $P < .001$) and PEOU ($\beta_2 = 0.29$, $P < .001$), supporting H₇ and H₈.

Additionally, nine model-fit measures were used to assess the overall goodness-of-fit of the model. The ratio of χ^2 ($\chi^2 = 3294.48$) to degree of freedom ($df = 1211$) was 2.720 for the measurement model. Moreover, the GFI was 0.68, and the PGFI was 0.62. The NFI and NNFI were both 0.98, exceeding the 0.90 benchmark. The CFI was 0.98, exceeding the 0.90 benchmark. The RMSEA was 0.08, slightly exceeding the recommended range of acceptability (< 0.05 – 0.08). Finally, the RMR was 0.035, and the SRMR was 0.048. As shown, most fit indexes met the required criteria representing a reasonable fit, with the exception of GFI. No absolute threshold levels for acceptability have been established.³⁴ One possible explanation for the slightly lower fit value of GFI may be a sharp increase in the number of the factors in the overall model.³⁷

DISCUSSION AND CONCLUSION

Using SEM analysis, empirical testing of the research model determined that all paths were significant in the hypothesized directions; the proposed model explains nurse acceptance of the HISs. Our study found that (1) system quality, information quality, and service quality influence PU and PEOU of HISs; information quality has a major impact on PU and PEOU; (2) PU and PEOU influence acceptance of HISs by nurses; perceived usefulness in particular has a major impact on acceptance of HISs; and (3) the proposed research model is both valid and reliable.

This study assumed that system quality, information quality, and service quality have a positive influence on PU and PEOU. The relationships between those



R^2 : coefficient of determination; significance levels: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

FIGURE 2. Standardized solution of the structural model.

construct are supported by the empirical data of the nursing personnel. The coefficient for determination (R^2) indicates that the model explains 72% of the variance associated with PU and 69% of the variance associated with PEOU. These results show that HIS information quality has the most significant impact on PU ($\gamma_3 = 0.57$, $P < .001$). Healthcare professionals are likely to accept technologies that provide useful healthcare information.^{17,20} In addition, IT enhances the professional autonomy of nurses.^{20,38} For nurses, the key functions of information systems include retrieving, transferring, storing, or viewing healthcare information.^{18,39} This study shows that high-quality information helps to integrate healthcare processes and medical knowledge.⁴⁰ Thus, to be accepted, HISs must provide high-quality healthcare information to nursing staff.

Information quality, rather than system quality or service quality, exerts the greatest impact on PEOU ($\gamma_4 = 0.61$, $P < .001$). This reveals that higher HIS information quality influences the perceptions of nurses regarding the ease of use. This indicates that nurses view an information system as easy to use based on the quality of information. Researchers have shown that the availability of hardware, content design, and user training/education programs are critical factors in integrating computers in the daily regimen of nurses.⁵ In addition, nurses are concerned that content design should be based on nursing care, not traditional medical classifications.⁴¹ Improving information quality in HISs (eg, unified nursing language) would help nursing staff to better understand patient conditions; therefore, high information quality helps nurses to use the HISs in support of their nursing activities.

Perceived usefulness ($\beta_1 = 0.61$, $P < .001$) influenced HIS acceptance more than PEOU ($\beta_2 = 0.29$, $P < .001$). The coefficient for determination (R^2) indicates that the model explains 75% of the variance associated with the acceptance of HISs. These findings are consistent with the views of healthcare professionals regarding information on the acceptance of systems.^{17,18,20,21,42,43} Healthcare professionals appear fairly pragmatic, focusing on the usefulness of technologies rather than their ease of use.¹⁷ Nurses are likely to accept (or use) the HIS when it is considered useful to his/her practice. Other researchers have demonstrated that healthcare providers consider useful, relevant, and high quality to be important attributes of patient health information.^{32,34} Thus, nurses with a positive attitude to HISs will have a higher acceptance of HISs. In addition, TAM also suggests that PEOU and PU in IT/IS determine the attitudes of individuals with regard to IT/IS.⁸ To this extent, information usefulness and ease of use are important factors in the acceptance of HISs.

This study makes several contributions to our current understanding of HIS usage in nursing activities, with several important implications. Based on the above results

and discussion, health organizations must facilitate access to patient health information, to increase the acceptance of HISs by nurses. Nurses require high-quality healthcare information, and higher HIS information output quality supports and encourages nurses to use IS at work. This research has proven the significance of ease of use and information output quality. Health organizations must also deal with increasing the acceptance of IS by creating a favorable environment to support and encourage the usage of IS in daily nursing care.⁴² For instance, well-organized patient health information improves access, making it more likely that nurses will form a positive intention to use it in their jobs. Medical care and nursing care are supported by supply activities, which are reported to healthcare management through coordinated processes.¹⁰ Nurses depend heavily on rich, accurate information related to patient health to support them in the provision of treatment, and nursing professionals tend to be pragmatic, considering the role of HISs in nursing care activities. Therefore, hospitals need to integrate a large number of heterogeneous distributed healthcare information systems to provide nurses with useful patient care information.⁴⁴

In conclusion, in adopting HISs, health organizations must ensure the quality of information, as it is closely related to the perception of nurses regarding the usefulness and ease of use. To encourage individuals to adopt and use the HISs, managers must place a greater emphasis on facilitating the conditions, training, and the usefulness of the HISs. Integrating operational procedures and sources of information upon its introduction is critical to promoting the acceptance of HISs among nursing professionals. Finally, HISs must provide up-to-date information, cross-linked across various platforms, and available in real time at the point of care.

LIMITATIONS AND RECOMMENDATIONS

The findings of this study are subject to three major limitations. First, the study was conducted in a single regional hospital. As a result, the respondents may not adequately represent the entire population of nursing staff. This study used a self-appraisal survey instrument, which may include inherent limitations derived from the survey methodology. Finally, we tested only cross-sectional data collected by nurses at one time. We suggest that future researchers conduct longitudinal studies to further explore the issues the adoption of technology by healthcare professionals.

This study recommends several directions for future research. This study explored the acceptance of an HIS by nurses in a regional hospital in Taiwan, adopting the perspective of nurses to establish a research model. Future researchers should examine the acceptance of HISs and the perspectives of other healthcare staff. Although this

study clearly demonstrated the antecedent role of information quality and PU, it is important to identify additional variables that can improve our ability to more accurately predict usage intention.

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