

Understanding key factors affecting on hospital electronic health record (EHR) adoption

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ABSTRACT

Introduction: This study investigated the factors affecting the acceptance of hospital electronic health record (EHR) adoption by users based on Technology Acceptance Model3 (TAM3). **Methods:** The self-administered TAM3 questionnaire was used for data gathering. Content validity and reliability of the TAM3 questionnaire were measured. The relation between dependent, independent, and mediator variables was analyzed using multiple regression analysis. **Results:** The results from 224 users indicated that subjective norm, job relevance, output quality, voluntariness, computer experience have significant impacts on perceived usefulness. Also, perceptions of external control and computer anxiety were identified as having significant impacts on perceived ease of use. Perceived usefulness did not have a mediator role between result demonstrability and behavioral intention. Perceived ease of use was not found to be a mediating factor in the relationship between computer self- efficacy and behavioral intention, as well as perceived enjoyment. **Conclusions:** The findings of the current study, provide valuable scientific evidence for key affecting factors on hospital EHR in Iran as a developing country. Our results showed the main constructs and relationships depicted in the TAM3 were found to be applicable to assess the adoption of hospital EHR.

Keywords: Adoption, and sociotechnical aspects of information technology, electronic health record, hospital information system, technology acceptance model

Introduction

Today, shifting healthcare services into electronic health records (EHR) has become a national priority.^[1] EHR is a social-technical system.^[2] The socio-technical systems involve increasingly complex social arrangements, and in turn, the social arrangements for patients' health care and clinicians' work more and more are parts of increasingly complex socio-technical

systems.^[3] Understanding the factors affecting hospital EHR adoption by users is a vital topic. The aims of the study were: to evaluate the relation between independent and dependent based on TAM3, to investigate the effect of mediator variables in TAM3, and to determine influencing factors on EHR use.

Materials and Methods

Research framework

TAM was developed by Davis *et al.* in 1989.^[4] TAM generally was used for predicting acceptance, adoption, and use of information systems with various populations and technologies including healthcare.^[5-10] In the current study, the TAM3 was adopted as the

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research framework. The TAM3 consists of four main constructs: perceived usefulness, perceived ease of use, behavioral intention, and use behavior.

According to TAM3, perceived usefulness and perceived ease of use are mediator variables that cause mediation in the dependent (behavioral intention) and the independent variables. Eight independent variables including subjective norm, image, job relevance, output quality, result demonstrability, voluntariness, computer experience, EHR experience can influence perceived usefulness. As well, six independent variables including self-efficacy, perception of external control, computer anxiety, perceived enjoyment, computer experience, and EHR experience can influence perceived ease of use.^[11] Table 1 shows the study's hypothesis.

Instrument

In the current study, the standard TAM3 questionnaire was used for data gathering which was a self-administered structured tool. The 47 items questionnaire was translated from English into Persian. The translation process to produce the Persian version of the questionnaire utilizes a decentring technique involving paraphrasing and translation between source and target languages. Backward translations were applied in the translation process. The questionnaire in English was translated into Persian by two independent translators who are well versed in Persian and expert about the content of the questionnaire. In order to achieve high-quality translation, the reliability, fluency, and appropriateness of the translated questionnaire were greatly emphasized.

The questionnaire was validated by an expert panel with CVI: 0.85 and CVR: 0.86. The overall Cronbach's alpha value of the instrument was determined as 0.902, demonstrating high reliability.

Study settings and participants

The study conducted in a large teaching hospital in Iran. The case hospital has implemented a customized hospital EHR from 2002. All Registered users in the EHR database were asked to participate in the study. Given, the high number of users in the clinical departments ($n = 1450$), 10% of them were considered sample size.

Data collection

This research was approved by the ethical committee. The researches met all users' EHR in person and invited them to participate in the study. Questionnaires were provided to users who agreed to participate in this study. Participation in this study was voluntary and the participants could withdraw from the study at any time without any penalty.

Statistics

Summary statistics for the participants were calculated as frequencies and proportions. Statistical significance for all of

Table 1: Study's hypothesis and summary of results

Hypothesis	P	Results
Ha1: Subjective norm --> Perceived HIS usefulness	0.007	Supported
Ha2: Image --> Perceived HIS usefulness	0.147	Supported
Ha3: Job relevance --> Perceived HIS usefulness	0	Supported
Ha4: Output quality --> Perceived HIS usefulness	0.041	Failed to support
Ha5: Result demonstrability --> Perceived HIS usefulness	0.36	Failed to support
Ha6: Voluntariness --> Perceived HIS usefulness	0	Supported
Ha7: Computer experience --> Perceived HIS usefulness	0.03	Supported
Ha8: HIS experience --> Perceived HIS usefulness	0.986	Failed to support
Hb1: Self-efficacy --> Perceived HIS ease of use	0	Supported
Hb2: Perception of external control --> Perceived HIS ease of use	0.027	Supported
Hb3: Computer anxiety --> Perceived HIS ease of use	0	Supported
Hb4: Perceived enjoyment --> Perceived HIS ease of use	0	Supported
Hb5: Computer experience --> Perceived HIS ease of use	0.826	Failed to support
Hb6: HIS Experience --> Perceived ease of use	0.826	Failed to support
Hc1: Subjective norm --> Behavioral intention	0.224	Failed to support
Hc2: Image --> Behavioral intention	0.852	Failed to support
Hc3: Job relevance --> Behavioral intention	0.700	Failed to support
Hc4: Output quality --> Behavioral intention	0.524	Failed to support
Hc5: Result demonstrability--> Behavioral intention	0.012	Supported
Hc6: Voluntariness --> Behavioral intention	0.553	Failed to support
Hc7: Self-efficacy --> Behavioral intention	0.014	Supported
Hc8: Perception of external control --> Behavioral intention	0.727	Failed to support
Hc9: Computer anxiety --> Behavioral intention	0.250	Failed to support
Hc10: Perceived enjoyment--> Behavioral intention	0.002	Supported
Hc11: Computer experience --> Behavioral intention	0.440	Failed to support
Hc12: HIS experience --> Behavioral intention	0.793	Failed to support
Hc13: Perceived usefulness --> Behavioral intention	0.000	Supported
Hc14: Perceived ease of use --> Behavioral intention	0.014	Supported
Hd1: Perceived usefulness --> HIS use behavior	0.083	Failed to support
Hd2: Perceived ease of use --> HIS use behavior	0.492	Failed to support
Hd3: HIS behavioral intention -->HIS use behavior	0.003	Supported

the analysis was defined as $P \leq 0.05$. The IBM SPSS version 21 was used to analyze the data. In the present study, multiple LR

analysis was performed to examine the relationship between the dependent variable and the independent variables.

Results

Participants

A total of 260 questionnaires were distributed to all of the target users. Finally, 224 valid questionnaires were collected. (Response rate 86.1%). Response rates were robust across hospital departments. Around two-thirds of the participants were female and most of the users were aged 30-39. The majority of the participants had a Bachelor's degree (75.9%). In total 82.5% and 67% of all participants had more than 5 years of computer experience and EHR experience, respectively. In total 87.9% of the users had an ICDL certificate.

Hypotheses testing results

Ha1, Ha3, Ha4, Ha6, and Ha7 hypotheses showed that there was a significant relationship between each of the independent variables including subjective norm, job relevance, output quality, voluntariness, and computer experience with perceived usefulness. According to the results of Hc1, Hc3, Hc4, Hc6, and Hc11 hypotheses a significant relationship between each of the mentioned independent variables and the behavioral intention was not observed. Thus, the variable of perceived usefulness had a mediator effect between these independent variables and behavioral intention.

On the basis of the results of Ha2, Ha5, and Ha8 hypotheses, there were not the positive relations between three independent variables including image, result demonstrability, and EHR experience with perceived usefulness. Also, the significant relations between image, as well as EHR experience with behavioral intention were not observed. But, the results revealed that behavioral intention was significantly influenced by result demonstrability.

The results of the Hb1Hb4 hypotheses indicated that perceived ease of use was significantly influenced by computer self-efficacy, perceptions of external control, computer anxiety, and perceived enjoyment. As well, according to the results of Hc7 and Hc10 hypotheses, there were significant relations between computer self-efficacy and perceived enjoyment with behavioral intention. Therefore, perceptions of external control and computer anxiety were predictors for perceived ease of use and had indirect effects on behavioral intention. But, computer self-efficacy and perceived enjoyment had significant direct effects on perceived ease of use and behavioral intention.

The results of the Hd1Hd2 hypotheses indicated that there were not positive relations between “perceived ease of use” and “perceived usefulness” with “use behavior”. Also, according to the results of Hc13, Hc14, and Hd3, the behavioral intention had significant relations with perceived ease of use, perceived usefulness, and use behavior. These results confirmed that

perceived ease of use, perceived usefulness were predictors of behavioral intention and had indirect effects on use behavior. And also, the behavioral intention has a mediating effect on the relationship between these variables and use behavior. Figure 1 shows key affecting factors on use behavior. Table 1 shows a summary of hypothesis results.

Discussion

The empirical findings completely confirmed the original TAM3 constructs including perceived usefulness, perceived ease of use, behavioral intention and use behavior influencing the adoption of the system. The most important findings of the current study will be discussed in the following paragraphs.

The results of the current study revealed that when an EHR is considered useful and easy to use by users, then there will be a behavior intention to use the system. Our findings support previous research by highlighting the positive relations between perceived usefulness and perceived ease of use 5, 79, 12 with behavioral intention. The results showed that perceived usefulness has a mediating effect on the relationship independent variables including subjective norm, job relevance, output quality, voluntariness, and computer experience. Thus, these variables were predictors of perceived usefulness. The findings of studies by Nadri *et al.*^[12] and Ebrahim *et al.*^[13] revealed that there were significant relations between job relevance and output quality with perceived usefulness. And also, perceived usefulness significantly influenced by subjective norm.^[10,13] The finding of the current study confirmed these results. The study of Steining and Stiglbauer showed a positive relationship between computer experience and perceived usefulness. They believed that the higher levels of computer experience lead to a better understanding of which component functions of the system are useful in daily routines.^[10] The results of the current study support their findings.

Nadri *et al.* found out there were not the positive relations between result demonstrability and image with perceived usefulness.^[12] Ebrahim *et al.* suggested that result demonstrability did not have a significant effect on perceived usefulness.^[13] The finding of the current study was in line with the above-mentioned studies. However, our results showed that result demonstrability and perceived usefulness did not have significant relation but, there was a positive relationship between perceived usefulness and behavioral intention. Therefore, “result demonstrability” is one the key affecting factors on hospital EHR adoption. It had a direct effect on behavioral intention and its' effect in research studies needs to be measured separately.

Our results indicated that EHR experience did not have a significant effect on EHR adoption. These are an explanation reasons for these results. EHR in the case hospital has been implemented for more than 15 years. Moreover, the majority of users (80%) in the study had more than a 3-year EHR experience. It seems a long term period of the system implementation and

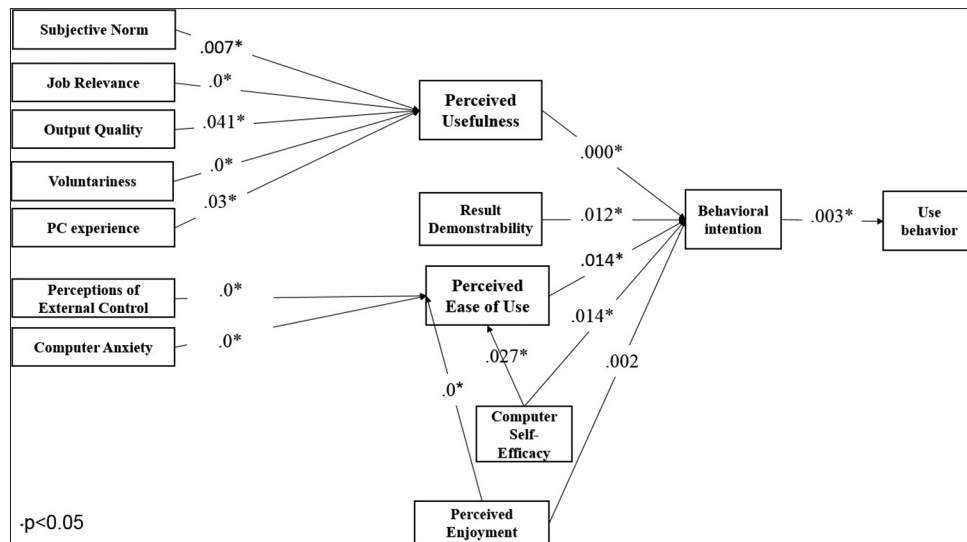


Figure 1: Key affecting factors on use behavior

extensive EHR experience did not have a significant effect on EHR adoption.

In the study by Nadri *et al.*^[12] and the current study a positive relationship between image and perceived usefulness was not observed. The image refers to “the degree to which an individual perceives that use of innovation will enhance his or her status in his or her social system”.^[11] It seems “image” is not one the key affecting factors on hospital EHR adoption. There is a possible reason for this finding. The adoption of the hospital EHR has been mandatory for all governmental hospitals since 2014. All users in this hospital must use EHR and they did not feel EHR adoption led to the improvement of social status. On the basis of our results, subjective norm had a significant influence on perceived usefulness. Subjective norm is “the degree to which an individual perceives that most people who are important to him think he should or should not use the system”.^[11] This finding confirmed societal pressure on users to use EHR.

According our results perceived ease of use has a mediating effect on the relationship between computer anxiety as well as perceptions of external control with behavioral intention. Perceptions of external control refer to organizational and technical resources that exist to support the use of the system for users.^[11] Perceptions of external control had a direct effect on perceived ease of use and it is a key factor for system adoption by users. It shows consistent results with the findings of previous studies. The lack of computer resource is one of the most important barriers of system adoption, specialty in a developing country.^[14-16]

The results of the study by Chen and Hsiao computer were found that self-efficacy did not have a significant effect on perceived ease of use. They believed most system adoption studies focused on evaluating factors affecting behavior intention in the pre-implementation stage. Also, they stated all participants in their study had prior experience with IT.^[6] The current study

was conducted, similar to a study by Chen and Hsiao, after system implantation. Out of all users, 93% in the study had more than a 3-year computer experience. Our results revealed that computer self-efficacy and perceived enjoyment had significant direct effects on perceived ease of use and behavioral intention. Therefore, it seems the effect of these variables on the behavioral intention may be measured directly.

Although the findings of the current study, provide valuable scientific evidence for key affecting factors on hospital EHR for healthcare providers, managers, and policymakers to develop the strategies and policies for the successful implementation and facilitation of the adoption of EHR among hospital. We are aware that our research may have two limitations. The first is, the current study was conducted in one hospital. The second is, we did not interpret the results according to various type of EHR users. Future studies could perform in more hospital. As well, they could investigate the association between various type of users and system acceptance.

Authorship

Authors including “ZE”, “HT”, and “MT” contributed to design the study, gathering and analyzing the data, and were major contributors in writing the manuscript. All authors read and approved the final manuscript.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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