EXAMINING HEALTHCARE PROFESSIONALS' ACCEPTANCE OF ELECTRONIC MEDICAL RECORDS USING UTAUT

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ABSTRACT

With the growing demand for digital information in health care, the electronic medical record (EMR) represents the foundation of health information technology. It is essential, however, in an industry still largely dominated by paper-based records, that such systems be accepted and used. This research evaluates registered nurses', certified nurse practitioners and physician assistants' acceptance of EMR's as a means to predict, define and enhance use. The research utilizes the Unified Theory of Acceptance and Use of Technology (UTAUT) as the theoretical model, along with the Partial Least Square (PLS) analysis to estimate the variance. Overall, the findings indicate that UTAUT is able to provide a reasonable assessment of health care professionals' acceptance of EMR's with social influence a significant determinant of intention and use.

Keywords: Technology acceptance, UTAUT, Electronic Medical Record

INTRODUCTION

One of the most notable and well-established streams of research in Information Systems (IS) over the past four decades has been focused on how and why people adopt information technology. The need to investigate the factors influencing successful acceptance and use arises, in part, due to the complex individual, technical and social/organizational interplay between people and technology. Technology acceptance research, therefore, seeks to clarify the factors that contribute to the success and failure of information systems and technologies.

When health information systems fail to be accepted and used, tremendous burdens are placed on the institutions responsible for the failure, as well as the patients and clinicians that require accessible and relevant information. These burdens can certainly be measured in economic terms; however, the impact of failure to accept and use might more importantly be a contributor to the growing problems of preventable medical errors, deaths and reduction in health care quality [14].

Today, it is almost unimaginable to consider health care without information technology. Clinical decision support systems (CDSS), computerized-provider order entry (CPOE), and longitudinal electronic medical records (EMR's) promise to make clinical information available at the right place and time, thereby reducing error and increasing safety and quality. It is critical that we understand the factors that influence the acceptance and use of health information systems. Technology that is not used at all or to its fullest cannot reasonably be expected to contribute to improving safety and quality.

The objective of this research is to leverage the UTAUT model to evaluate the acceptance and use of EMR's. The paper provides a brief review of the theoretical background and development of the various models of technology acceptance. The methodology used to validate the model is then explained, and the data and findings are presented.

RELATED WORK

Because of the very nature of information systems – the pairing of people *and* technology – technology acceptance research has been profoundly impacted by the theories of individual human and social behavior emerging from the disciplines of psychology and sociology. With its origin in the area of Social Learning Theory by Miller and Dollard [15], Social Cognitive Theory (SCT) is focused on the process of knowledge acquisition through observation [5]. This theory was later expanded, in particular by Albert Bandura and became known as SET, or Self-Efficacy Theory [4]. Two years prior to Bandura's work on Self-Efficacy, Fishbein and Ajzen [11] publish their research on the Theory of Reasoned Action (TRA). The theoretical basis for TRA lies in the tenets of social psychology, and has been widely accepted as a foundational theory of human behavior.

A product of TRA and SET, the Theory of Planned Behavior (TPB) emerges as an extension of TRA with perceived behavioral control from SET as an additional determinant of intention [1]. In 1991, Thompson et al. [19] published an alternative to TRA and TPB, the Model of PC Utilization (MPCU). This theory too has its roots in psychology, emanating most distinctly from the 1977 human behavioral research by Triandis [20].

The Technology Acceptance (TAM) model represents the first theory developed specifically for the IS context, i.e. people in business [9]. A few years later, Taylor and Todd [18] put forth their theory, known as Combined TAM-TPB, or C - TAM – TPB. This theory of technology acceptance combined the predictive elements of TPB with the concept of perceived usefulness from TAM. TAM was further extended to TAM2, and included subjective norm as a predictor in settings where use is mandatory [21].

The most recent model to emerge from this long line of study is known as the Unified Theory of Acceptance and Use of Technology (UTAUT) [22]. The UTAUT has been studied in at least six organizations and found to explain roughly 70% of the variance in user intention to use information systems [22]. The UTAUT integrates eight user acceptance models: TRA, TPB, TAM, TAM2, IDT, MM, PCI, MPCU, and finally, social cognitive theory (SCT). Each of these models has intention to use or actual usage as the dependent variable.

RESEARCH MODEL AND HYPOTHESES

The UTAUT attempts to explain intention to use, as well as subsequent usage behavior. The theory suggests that four key constructs: 1. Performance expectancy, 2. Effort expectancy, 3. Social influence, and 4. Facilitating conditions are direct determinants of usage intention and behavior [22]. Gender, age, experience, and voluntariness of use will mediate the impact of the four constructs on intention to use and usage behavior [22]. At this stage of the research, our research model captures direct determinants of usage intention and behavior as shown in Figure 1.

H1: *Performance Expectancy will influence behavioral intention to use an EMR;*

H2: *Effort expectancy will influence behavioral intention to use an EMR.*

H3: *Social Influence will positively influence behavioral intention to use an EMR.*

H4: *Facilitating conditions will have a significant influence on usage behavior.*

H5: *Behavioral intention will have a significant positive influence on usage.*

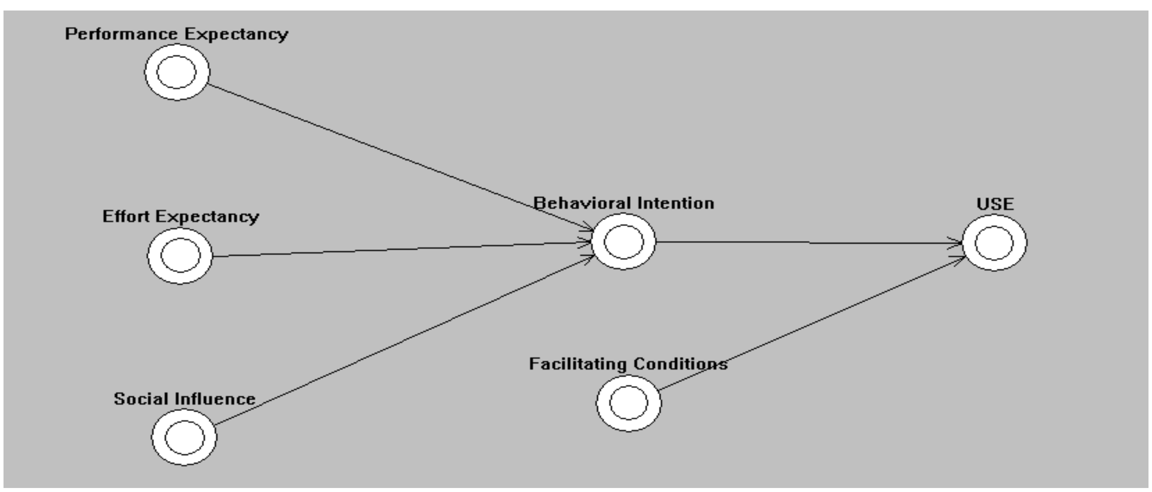

Figure 1. Unified Theory of Acceptance and Use of Technology (UTAUT) model

METHODOLOGY

Setting and context

The study was conducted through cooperation with the South Dakota Nurse's Association (SDNA), the South Dakota Academy of Physician Assistants (SDAPA) and the Nurse Practitioner Association of South Dakota (NPASD). South Dakota's health care is to a large extent maintained by three major health systems in two population centers, each of which has undergone, or is currently undergoing an EMR initiative.

Subjects

The participant's are members of the SDNA, SDAPA or the NPASD and are actively licensed registered nurses, physician assistants or certified nurse practitioners in the state of South Dakota.

Survey instrument

The survey instrument is based on constructs validated in prior research [22], standardized and adapted to the context of this study. The constructs include; Performance expectancy, Effort expectancy, Social influence, and Facilitating conditions. The survey instrument collects additional information such as gender, age, and geographic location in South Dakota; EMR features and frequency of use. All questionnaire items were measured using a 7-point Likert scale ranging from "strongly disagree" to "strongly agree".

Data collection

The survey instrument was made available to the participants through the World Wide Web using Checkbox Survey Server. Survey participants were contacted through their respective organization, and guided to the instrument by a series of emails requesting participation. Participants were assured response anonymity by not being required to provide identifying information on the survey.

Data analysis

Partial least squares (PLS) was the statistical technique used for analysis in this study. While the utility of PLS is detailed elsewhere [10], a number of recent technology acceptance studies have utilized PLS, including, but not limited to: [3; 7; 22].

To evaluate the measurement model, PLS estimates the internal consistency for each block of indicators. PLS then evaluates the degree to which a variable measures what it was intended to measure [8; 17]. This evaluation, construct validity, is comprised of convergent and discriminate validity. Following Gefen and Straub [13] convergent validity of the variables is evaluated by examining the t-values of the outer model loadings. Discriminate validity is evaluated by examining item loadings to variable correlations and by examining the ratio of the square root of the AVE of each variable to the correlations of this construct to all other variables [6; 13].

For the structural model, path coefficients are interpreted as regression coefficients with the t-statistic calculated using bootstrapping (100 samples), a nonparametric technique for estimating the precision of the PLS estimates [6]. To determine how well the model fits the hypothesized relationship PLS calculates an R^2 for each dependent construct in the model. Similar to regression analysis, R^2 represents the proportion of variance in the endogenous constructs which can be explained by the antecedents [6].

RESULTS AND DISCUSSION

Sample characteristics

Fifty two of the participants correctly completed the survey which asked questions requiring the participants to respond using a seven-point likert scale from "strongly disagree" to "strongly agree". 59% of the participants were between the ages of 35-54, with 94% of the individuals being female and 6% male.

Assessing measurement validity

Table 2 summarizes the results for the items comprising the model. The results show composite reliability (CR) exceeding 0.8 as recommended by Nunnally [16]. AVE which can also be considered as a measure of reliability exceeds 0.5 as recommended by [12]. Together CR and AVE attest to the reliability of the survey instrument. The t-values of the outer model loadings exceed 1.96 verifying the convergent validity of the instrument [13]. Calculating the correlation between variables' component scores and individual items reveal that intra-variable (construct) item correlations are generally high when compared to inter-variable (construct) item correlations. Discriminate validity is confirmed if the diagonal elements (representing the square root of AVE) are significantly higher than the off-diagonal values (representing correlations between constructs) in the corresponding rows and columns [6]. As shown in Table 3 the instrument demonstrates adequate discriminate validity as the diagonal values (bold) are greater with respect to the corresponding correlation values in the adjoining columns and rows.

Model testing results

Figure 2 depicts the structural model showing path coefficients and R^2 for dependent variables. The R^2 values for each dependent variable indicate that the model explained 51.1% of the variance for behavioral intention and 28.2% for use. The Bootstrap method was used in PLS-Graph to assess the statistical significance of the path coefficients. With respect to the key determinants of EMR acceptance, Social Influence has the most direct influence on intention to use, followed by performance expectancy, facilitating conditions and effort expectancy. Consistent with hypothesis 1 (H1), performance expectancy, or the degree to which a user believes the EMR will improve performance, has a positive effect on intention to use an EMR (β=0.269, p>0.1). Similarly, the degree of ease of use, effort expectancy (H2), associated with system use has a positive influence on intention to use an EMR (β=0.245 p>0.1). In the same manner, social influence (H3), the degree to which a user perceives the importance of others' opinion with respect to EMR use, also plays a significant role in intention to use an EMR, (β=0.324 p>0.05). The degree to which an individual believes that an organizational and technical infrastructure exists to support system use, facilitating conditions (H4), is also significant with respect to use (β=0.247 p>0.1). Finally, for hypothesis 5 (H5), Behavioral Intention has a significant influence on actual use (β=0.329 p>0.001).

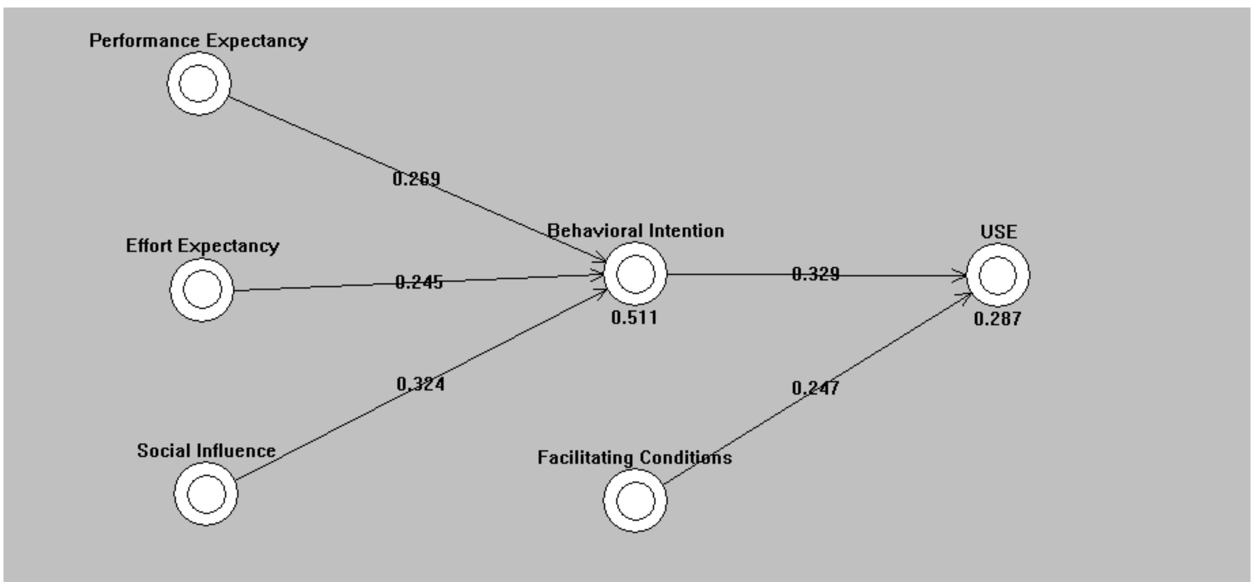

Figure 2. Model testing results

Consistent with prior research, Social Influence appears to be significant only in mandatory settings, as was the case for all participants in this study [21]. SI, also heavily moderated by age and gender, has also been found to be more significant among women in the early stages of experience [21]. In this study, 94% of the respondents were female, and the average EMR experience of the participant was approximately 12 months. In effect, social influence has a greater than expected impact on intention to use, and this underscores the need to more closely examine the potential moderating roles of gender, age and experience. Together the results indicate the importance of developing programs that support health professionals' performance expectancy, and social influence, while striving to ensure ease of use in the context of an EMR. Overall, the constructs of PE, EE, and SI together explain a reasonable 51.1% of the variance with respect to intent to use, while facilitating conditions in conjunction with intent explains 28.2% of usage behavior.

CONCLUSIONS

This study examined health professionals' acceptance and use of electronic medical records. Overall, the results suggest that the UTAUT model, though a reduced version, was able to provide a reasonable explanation of health professionals' acceptance of EMR's. With the growing demand for EMR's, evaluating the roles of the factors influencing adoption is a critical step toward defining success or failure with EMR initiatives. The primary implication of this research is that social influence may play a greater role in EMR adoption, particularly among women, than performance and effort expectancy. These results suggest that with respect to EMR adoption, acceptance and use could potentially be enhanced by strategic planning for and management of the factors that contribute to individual and organizational social influence. Broadly, the results can be used as valuable input for the management of socio-technical-based initiatives in health care. From a theoretical perspective, the research contributes to the broad adoption literature by examining the theoretical validity and empirical applicability of the UTAUT model.

Limitation and recommendations for future work include:

- Sample size – A sample size of 52 represents a limitation to this research.
- Gender biased – With 94% of respondents as female, future work should attempt to include a more accurate representation of healthcare professionals' gender distribution in South Dakota.
- Longitudinal evaluation – It is paramount to continue to evaluate health professionals' acceptance, use and performance over time.

Table 2. Individual Loadings, composite reliabilities (CR) and AVE.

Construct	Individual Items	Item Loading	Construct CR	Construct AVE
Performance Expectancy	PE1	0.909	0.959	0.887
	PE3	0.963		
	PE4	0.963		
Effort Expectancy	EE1	0.849	0.937	0.788
	EE2	0.886		
	EE3	0.914		
	EE4	0.902		
Social Influence	SI1	0.796	0.916	0.732
	SI2	0.836		
	SI3	0.889		
	SI4	0.894		
Facilitating Conditions	FC1	0.839	0.847	0.692
	FC3	0.723		
	FC4	0.909		
Behavioral Intent	BI1	0.839	0.742	0.592
	BI3	0.633		
Use	USE1	0.944	0.912	0.778
	USE2	0.915		
	USE3	0.744		

Table 3: AVE Scores and Correlation of Latent Variables.

	PE	EE	SI	FC	BI	Use
PE	**0.942**					
EE	0.650	**0.888**				
SI	0.568	0.558	**0.856**			
FC	0.661	0.691	0.738	**0.832**		
BI	0.613	0.601	0.614	0.706	**0.769**	
Use	0.360	0.592	0.510	0.470	0.507	**0.882**

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