

Understanding Intention to Use Electronic Information Resources: A Theoretical Extension of the Technology Acceptance Model (TAM)

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Abstract

This study extended the Technology Acceptance Model (TAM) by examining the roles of two aspects of e-resource characteristics, namely, information quality and system quality, in predicting public health students' intention to use e-resources for completing research paper assignments. Both focus groups and a questionnaire were used to collect data. Descriptive analysis, data screening, and Structural Equation Modeling (SEM) techniques were used for data analysis. The study found that perceived usefulness played a major role in determining students' intention to use e-resources. Perceived usefulness and perceived ease of use fully mediated the impact that information quality and system quality had on behavior intention. The research model enriches the existing technology acceptance literature by extending TAM. Representing two aspects of e-resource characteristics provides greater explanatory information for diagnosing problems of system design, development, and implementation.

Introduction

With the advancement of computer and networking technologies, there is a significant growth in availability and use of electronic information resources (e-resources). The Internet, online databases, e-journals, e-books, and various e-resources can be accessed through computers, PDAs, and other electronic devices. Most people prefer e-resources to traditional print and human information resources. However, factors that affect users' preferences for e-resources remain unknown. Previous user studies have investigated "what" and "how" e-resources are used, but have not answered "why", e.g. "why do users select and use an e-resource?", "what are the factors and how do those factors influence users' selection and use of e-resources?" Some scholars examined the impact that resource accessibility and quality had on resource usage and found inconsistent results.¹⁻⁴ However, none of these studies were theory-based nor conducted systematically. The lack of answering "why" questions in previous studies has limited the findings to guide and improve system design.⁵

In order to enhance acceptance and increase usage of e-resources, it is important to understand how users make decisions on selection and use of e-resources. The present study aims: 1) to identify specific e-resource characteristics that affect public health students' decisions to use e-resources for completing research paper assignments in a Midwestern university in the U.S., 2) to propose a theoretical model based upon the Technology Acceptance Model (TAM)⁶ and examine the relationship among e-resource characteristics, behavior beliefs, and behavior intention, and 3) to stimulate thoughts and provide recommendations for publishers and system designers to improve e-resources system design, development, and implementation.

Theoretical Background

Technology Acceptance Model (TAM)

Based on Fishbein and Azjen's Theory of Reasoned Action (TRA)⁷, Davis⁶ proposed the Technology Acceptance Model (TAM), which aims to predict system acceptance and to diagnose design problems. According to TAM (Figure 1), user acceptance of any technology, measured by a person's intention to use the technology, is determined by two beliefs, namely, perceived ease of use and perceived usefulness, which mediate the effects that external variables have on usage intention. In addition, perceived ease of use also influences perceived usefulness.

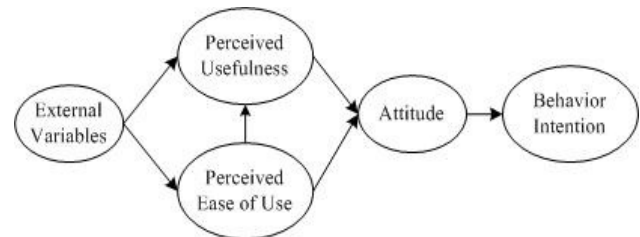


Figure 1. The Technology Acceptance Model (TAM)

Research Model

Based on TAM and the reviewed literature, a research model was proposed (Figure 2) with arrows representing causal relationships. According to the model, intention to use e-resources is the behavior intention (BI) construct and is a function of two

concrete behavior beliefs: perceived usefulness (USE) and perceived ease of use (EOU). Information quality (IQ) and system quality (SQ) represent two aspects of e-resources characteristics by serving as external variables that indirectly affect BI through directly influencing USE and EOU.

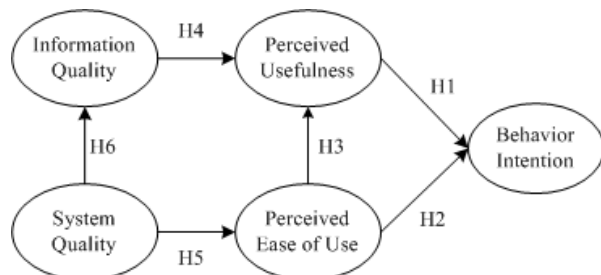


Figure 2. The research model

Attitude construct was removed from the research model based on Fishbein & Ajzen's statement that "as a person forms beliefs about an object, he automatically and simultaneously acquires an attitude toward that object."⁷ (p39) Davis⁶ also found that the model with the attitude construct removed was "a powerful [model] for predicting and explaining user behavior based on only three theoretical constructs: intention, perceived usefulness, and perceived ease of use." (p997) Many empirical studies also used simplified TAM and found significant causal relationships between behavior beliefs and behavior intention.⁸⁻¹²

Information quality and system quality represent two aspects of e-resource characteristics and serve as external variables in the model. According to Ajzen & Fishbein¹³, consistency in time, target, and context with the behavior of interest is needed in order for a belief to be directly predictive of behavior. Information quality and system quality are beliefs about resources themselves rather than beliefs about using resources. It is beliefs about using resources (behavior beliefs) that directly predict use behavior while beliefs about resources themselves (object-based beliefs) are generally poor predictors of behaviors.¹³ However, behavior beliefs are formed and shaped from beliefs about behavior objects. Therefore, beliefs about e-resource characteristics formed and shaped beliefs about using e-resources, which therefore influence intention to use e-resources.

Hypotheses

By directly drawing constructs and their causal relationships from TAM, the impact of behavior beliefs on intention to use e-resources are proposed below:

Hypothesis 1: Perceived usefulness has a positive effect on intention to use e-resources.

Hypothesis 2: Perceived ease of use has a positive effect on intention to use e-resources.

Hypothesis 3: Perceived ease of use has a positive effect on perceived usefulness.

An e-resource can be seen as a web-based information retrieval (IR) system. Any IR system is a two dimensional entity: information contained in the system and system functionalities that store, process, retrieve, and display information. Information quality and system quality have been used to represent two dimensions of system's characteristics in previous studies and were found to have significantly impact on perceived usefulness and ease of use.^{4,10,12,14-17} Based on the previous findings, the following hypotheses are proposed:

Hypothesis 4: The quality of the information contained in e-resources has a positive effect on perceived usefulness.

Hypothesis 5: System quality has a positive effect on perceived ease of use.

As stated above, object-based beliefs form and shape behavior beliefs. The relationship between two behavior beliefs is not formed automatically unless the corresponding behavior-object-based beliefs have the similar causal relationship. Consistent with the notion that perceived ease of use influences perceived usefulness, the research model hypothesizes that system quality will influence information quality. A positive perception about system functionalities and interface is likely to influence users' perception about the quality of the information the system produces.¹⁷

Hypothesis 6: System quality has a positive effect on information quality.

Methods

All students (N=282) enrolled in the School of Public Health during the spring semester in 2007 in a Midwestern university in the U.S. were study subjects. Both focus groups and a questionnaire survey were used to collect data. The purpose of the focus groups was to ensure the face validity and content validity of the questionnaire. 10 students were asked to brainstorm on all of the information resources they might use for their research papers and card sorting was performed to assess construct validity. The 22 index cards representing 22 question items measuring 5 constructs were given to students individually and each student was asked to sort the cards into 5 appropriate construct categories.

The questionnaire was administered through mass emailing, including two email reminders, campus mailing, and face-to-face distribution in class, before students started their assignments. An \$8 gift

certificate was provided to each participant as an incentive. Students who attended the focus groups were excluded from the questionnaire distribution.

Measurements

Four items measuring each of three constructs of TAM were drawn from validated scales in prior research,^{6,7,18} with minor wording modifications of the questions to fit the study context. Measures of information quality (4 items) and system quality (6 items) constructs were adapted from other system acceptance studies.^{4,10,12,14-17} All these measures were phrased as questions on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree).

Data Analysis

Descriptive analysis, data screening, and Structural Equation Modeling (SEM) techniques with SPSS 15.0 for Windows and AMOS 7.0 statistic applications were used for data analysis.

SEM is a multivariate statistical technique which incorporates and integrates multiple regression/path analysis and factor analysis. It is decomposed into two steps: confirmatory factor analysis (CFA) measurement model estimation and SEM structural model analysis. CFA measurement model estimation is to ensure the reliability and validity of measures and constructs and SEM structural model analysis is to estimate causal relationships among constructs. It is critical that measurement of each construct is psychometrically sound before testing the causal relationships among constructs.

Results

Descriptive Analysis

A total of 160 students (160/282=56.7%) responded the questionnaire. 134 students (134/160=83.8%) fully completed the questionnaire. Among them, 116 students indicated they intended to use e-resources to finish their paper assignments. Online databases, the Internet, and electronic journals were three most popular e-resources that students intended to use.

Measurement Model Estimation

Through data screening, there were no missing values and 22 items measuring 5 constructs were normally distributed and no outliers were detected. In order to ensure measures are psychometrically sound, item and construct reliability, as well as convergent and discriminant validity, were assessed. Squared factor loading (SFL) was used to test item reliability while Cronbach's α and composite reliability ρ were used to test construct reliability. The SFLs of 22 measured items, Cronbach's α and composite reliability ρ of 5 constructs ranged from 0.50-0.90 (SFL), 0.85-0.91(α) and 0.81-0.90 (ρ), respectively, which met the criteria

with SFL ≥ 0.50 , Cronbach's $\alpha \geq 0.70$, and composite reliability $\rho \geq 0.70$.¹⁹

Convergent validity was assessed with average variance extracted (AVE). AVEs of all 5 constructs ranged from 0.54 to 0.73, greater than the recommended value 0.50.¹⁹ Discriminant validity is verified with the average variance, which is shared between a construct and its measured items, greater than the variance, which is shared between the construct and other constructs.¹⁹ Table 1 presents that all construct AVEs on the diagonal row are larger than other values in the corresponding construct column.

Constructs	BI	USE	EOU	IQ	SQ
BI	0.73				
USE	0.13	0.70			
EOU	0.03	0.36	0.67		
IQ	0.07	0.23	0.14	0.56	
SQ	0.06	0.24	0.41	0.30	0.54

Table 1. Discriminant validity table

Structural Model Analysis

Maximum likelihood estimation was employed to compute path coefficients between constructs. Chi-square (X^2), Chi-square X^2/df , Goodness of Fit (GFI), Adjusted Goodness of Fit (AGFI), Norm Fit Index (NFI), Comparative Fit Index (CFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA) were used to evaluate model fit.²⁰ Table 2 presents the summary of fitting results for the structural model. All model fit indices met the recommended criteria.

Model Fit Index	Recommended Values	Reported Values
X^2	$P \geq 0.05$	$P = 0.268$
X^2/df	≤ 3.00	1.317
GFI	≥ 0.90	0.991
AGFI	≥ 0.80	0.933
NFI	≥ 0.90	0.983
CFI	≥ 0.90	0.996
RMR	≤ 0.09	0.040
RMSEA	≤ 0.10	0.052

Table 2. Reported values of model fit

Figure 3 presents the results of causal relationships with estimated path coefficients and associated t value. Only USE was found significantly affecting BI (H1) ($\beta = 0.32$, $t = 3.13$) while EOU had the indirect impact on BI through its significant direct effect on USE (H3) ($\beta = 0.36$, $t = 3.96$). USE had the larger total effect ($\beta = 0.320$) on BI than EOU ($\beta = 0.134$).

As postulated, IQ significantly affected USE (H4) ($\beta = 0.32$, $t = 3.636$) and SQ had the significant impact

on EOU (H5) ($\beta = 0.52, t = 5.72$). The impacts that both IQ and SQ had on BI were mediated through USE and EOU. In addition, SQ had the strong positive impact on IQ (H6) ($\beta = 0.54, t = 6.87$). Overall, the research model explained 10.8% of the variance in BI, 35.5% in USE, 33.5% in EOU, and 29.1% in IQ.

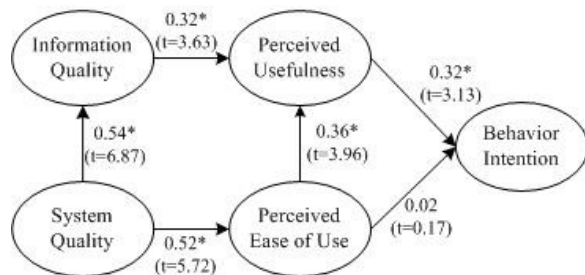


Figure 3. Results of structural model analysis
(* indicates $P < 0.05$)

Discussion

Theoretical Implications

Information resource use has been studied in the fields of organizational behavior, library and information science, and information technology.⁸ However, few studies use TAM to systematically investigate and explain this phenomenon. Although TAM has been popular in its predictive power of technology usage, only a few studies investigated the roles of system characteristics as antecedents to perceived usefulness and ease of use.^{12,15,17} The research model in this study enriches the existing technology acceptance literature. In addition, specifying concrete aspects of system characteristics provide a platform for more detailed investigations into more comprehensive system characteristics with reliable and valid measures.

Furthermore, the proposed model differentiated perceptions about resource characteristics (behavior-object-based beliefs) from perceptions about using resources (behavior-based beliefs). In order to test if IQ and SQ have the direct impact on BI, two causal paths from IQ to BI and from SQ to BI were added to the structural model. Neither IQ ($\beta = 0.07, t = 0.639$) nor SQ ($\beta = 0.133, t = 1.133$) were found to have the direct and significant impact on BI while the significant causal paths remained the same as the results obtained from the hypothesized research model. This finding confirmed that behavior-based beliefs fully mediate the relationships between object-based beliefs and behavior intention, which sheds light on the reason for the inconsistent findings of previous studies that hypothesized that perceived resource characteristics had direct effects on the usage of an information resource.

Practical Implications

The proposed research model and the study findings provide important guidance to system designers to look into the specific system design aspects that impact users' acceptance of IR systems and had diagnostic value at any stage of a system's implementation or usage process.

The study found that perceived usefulness is a major determinant of behavior intention, which implies that, in the long run, although ease of use is clearly important, usefulness is even more important and should not be overlooked. "No amount of ease of use will be able to compensate for a system that doesn't do a useful task."²¹ (p. 1000) However, the significant impact of perceived ease of use to perceived usefulness implies the important role that ease of use plays in having system perceived as useful. System designers and developers must acknowledge that system ease of use is not independent of any particular task context²². A system that can make users find needed information for their tasks with easy-to-use functionalities is perceived useful. In order to increase perceived usefulness of an IR system, system's capabilities must match a person's job content. Therefore, system designers should not only consider interface design, but should begin at the task level.

Study Limitations

The present study only sampled public health students from one academic institution rather than all 37 accredited schools of public health in the U.S. Surveying more public students in other universities with the same instrument may obtain more generalized data. In addition, the research model should be tested for reliability and validity with different user groups in different settings with various information seeking contexts.

Further Studies

The study only found low variance (10.8%) accounted for in behavior intention, which indicated that some important predictors may be missing. For example, perceived behavior control based on the Decomposed Theory of Planned Behavior (DTPB) could be added as another behavior belief construct.¹⁸

Although behavior intention is considered to be an accurate predictor of actual usage behavior in TAM,⁶ some studies found that behavior intention did not significantly correlate to actual behavior.^{9,23} It would be interesting to further investigate whether public health students actually use the e-resources they intended to use, reasons for changing resources, and whether the determinants of behavior intention can also be used directly to predict actual use.

Conclusion

The present study proposed an extended model based on TAM to investigate the impact of two specific aspects of system characteristics on public health students' intention to use e-resources. It enriches the existing technology acceptance literature and provides practical guidance for system designers to evaluate specific design aspects. Most currently enrolled students in the health sciences field are Millennials²⁴ and they are digital natives as they were born in an age full of electronic resources and devices. With the trend of integrating e-resources into Electronic Medical Record systems and telemedicine techniques, it is critical for e-resource publishers and system designers to design both useful and easy-to-use IR systems in order to enhance system acceptance and to smooth system implementation for future health sciences professionals.

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