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Abstract

The Technology Acceptance Model (TAM) has been widely examined by information systems (IS) researchers with inconclusive findings. This research uses confirmatory factor analysis and structural equation modeling techniques to validate the model in the context of Internet tools. It finds strong support for the model even under perturbations of gender, age, experience, and intention of use of the respondents. The study thus reaffirms the importance of TAM in IS research and the model's relevance to Internet technologies.

Introduction

Researchers have observed that end-users are often unwilling to use available IS, that if used, would generate significant performance gains. In fact, most IS failures stem from a lack of user acceptance rather than poor technical quality (Nelson and Cheney, 1987). Managers thus require a better understanding of why people resist using computers in order to devise practical methods for improving user acceptance (Davis, Bagozzi and Warshaw, 1989).

According to Davis (1989), among the many variables which influence people to accept or reject information technology, two are especially important. First, people tend to use or not use an application to the extent they believe it will help them perform their job better. This is referred to as "perceived usefulness." Second, even if potential users believe that a given application is useful, they may, at the same time, believe that the system is too hard to use and that the performance benefits of usage are outweighed by the effort of using the application. Thus in addition to usefulness, usage can also be influenced by "perceived ease of use."

In the context of this study, *perceived usefulness* is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p.32). On the other hand, *perceived ease of use* is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p.32). These two variables influence the *attitude* of end users towards a particular technology and thus indirectly influence the actual usage of the technology. Taylor and Todd (1995, p. 561) define attitude as the reflection "...of feelings of favorableness or unfavorableness toward using the technology..."

The model described above, known as the Technology Acceptance Model (TAM) has been examined by many studies in different contexts (Davis, 1989; Venkatesh and Davis, 1996; Gefen and Straub, 2000). However, these studies have proved inconclusive in validating the model (Gefen and Straub, 2000). These inconclusive findings coupled with a lack of research on user acceptance of Internet tools such as E-mail and the WWW in academic environments provided the motivation for this

study. Therefore, the main purpose of this research was to examine the effects of perceived ease of use and perceived usefulness on the attitude towards use and actual use of E-mail and the WWW.

Methodology

Data on the usage of Internet tools was collected by means of a survey that consisted of three primary sections. In the first section, general background questions were asked about the respondent, such as their gender, age, and experience in using computer technology.

The second section dealt with the usage of e-mail packages. Respondents were asked to indicate which e-mail package they used most frequently (Independent sample t-tests indicated no significant differences among the e-mail packages for the dependent variables used in the study). Respondents were then asked to indicate the tasks they utilized e-mail for. Two measures of the extent of use of e-mail were also included in the survey (Davis, 1993). The first measure was that of frequency of use of e-mail, i.e., how many times the respondent had used e-mail over a certain period of time. The second measure was that of daily usage of e-mail, i.e., in a single day, how many hours did the respondent spend using e-mail. Measures for attitude, perceived ease of use, and perceived usefulness were derived from Davis (1993) with some modifications.

The third section of the survey dealt with usage of the WWW. The format for this section was exactly the same as it was for the previous section except for two differences. First, respondents were asked to indicate the web browser they used the most (Independent sample t-tests indicated no significant differences among the web browsers for the dependent variables used in the study). Second, changes were made in the wording of the questions in order to reflect the usage of the Web.

Subjects for this research project were students in an introductory MIS course taught at a major mid-western university. A total of 349 students across twelve sections of the course participated in the survey.

Data Analysis

Anderson and Gerbing (1988) have recommended a two-step approach in using covariance structure analysis for testing theoretical models. The first step of this process involves using confirmatory factor analysis to develop an acceptable measurement model. A measurement model is a factor-analytic model derived from theory in which the researcher identifies the latent (i.e., unobservable) constructs of interest and also indicates which observed variables will be used to measure each latent construct. In the measurement model, no causal relationships between the latent constructs are specified. Instead, each latent construct is allowed to covary (correlate) with every other latent construct (Hatcher, 1994). Statistical tools such as LISREL, and CALIS (SAS) can be used to verify that the measurement model displays an acceptable fit to the data, and also how to modify the model to achieve a better fit.

Once a measurement model with acceptable fit is developed, it can be modified to specify causal relationships between some of the latent variables. These modifications are made so that the model comes to represent the theoretical causal model that the researcher wants to test (Hatcher, 1994). Thus, the resulting theoretical model is a combined model that consists of two components: (1) a measurement model (that specifies the relationships between the latent constructs and their indicator variables), and (2) a structural model (that specifies causal relationships between the latent constructs). When performing path analysis with latent variables, the researcher tests whether this combined model, as a whole, provides acceptable fit to the data. If it does, then the theoretical model has survived an attempt at disconfirmation and gains support for its predictions (Hatcher, 1994).

Measurement Model Analysis

Confirmatory Factor Analysis using the CALIS procedure of SAS was used to test the Technology Acceptance Model for both E-mail and WWW use. In both cases, six variables were postulated to load on the construct perceived ease of use, six variables to load on the construct perceived usefulness, and seven variables to load on attitude toward use.

The CALIS procedure recommended refinements to the “initial models.” The recommendations were intended to improve psychometric properties. A number of criteria are generally used to assess the "goodness" of models. The most popular index is perhaps the chi-square statistic (Joreskog and Sorbom, 1993). Significant values of this chi-square indicate poor model fit while non-significant values indicate good fit. However, in large samples, the chi-square statistic is almost always significant since chi-square is a direct function of sample size (Hartwick and Barki, 1994; Hatcher, 1994). Hence, many researchers recommend that multiple fit criteria be used in order to minimize biases in results (Bollen and Long, 1989; Breckler, 1990). Thus, other popular measures include chi-square divided by degrees of freedom (recommended to be less than 2), Non-Normed Fit Index, Normed Fit Index (NFI) and Goodness of Fit Index (GFI) (which are all recommended to be greater than 0.9).

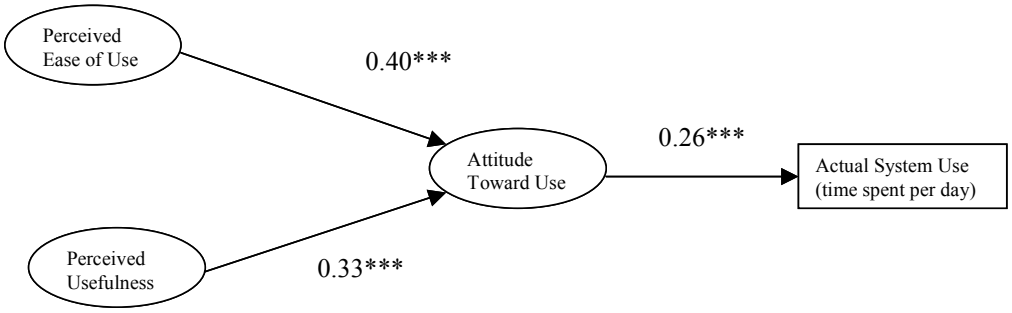
The steps in the refinement process of the measurement model for E-mail and the WWW can be obtained from the authors. The net result was the exclusion of five items each from the E-mail model as well as the WWW model (Hatcher, 1994).

Structural Equation Model Analysis

Structural equation models for the use of E-mail are shown in Figures 1 and 2, and for the WWW in Figures 3 and 4. Significant paths exist in all four figures from perceived ease of use to attitude towards use, perceived usefulness to attitude towards use, and

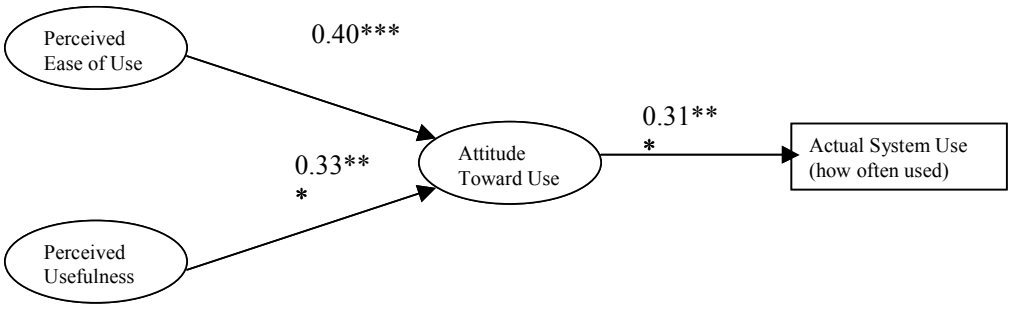
finally from attitude towards use to actual system use. These findings show strong support for the TAM in the context of Internet tools.

In order to test the validity of the Technology Acceptance Model under different conditions, separate structural equation models were developed for male and female respondents, as well as for respondents who were less than 20 years old, respondents who were more than 20 years old, respondents who had less than three years of computer experience, respondents who had more than three years of computer experience, respondents who used the technology for social communications and respondents who used the technology for educational purposes. The model was found to hold in all cases as shown in Tables 1 and 2.



Note: *p < .05, **p < .01, ***p < .001

Figure 1. TAM for E-mail (Time Spent per day)
(Fit Indices: χ^2/df = 2.1, prob > χ^2 = 0.0001, GFI = .929, NNI = .966, NFI = .947)

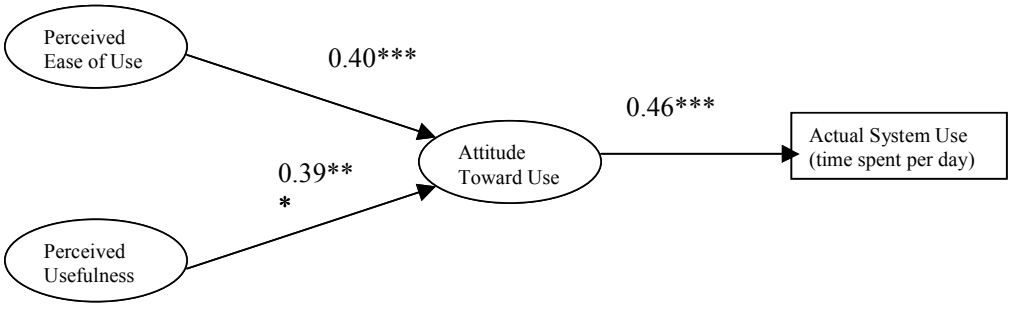


Note: *p < .05, **p < .01, ***p < .001

Figure 2. TAM for E-mail (How Often Used)
(Fit Indices: χ^2/df = 1.88, prob > χ^2 = 0.0001, GFI = .939, NNI = .972, NFI = .953)

Implications and Conclusion

This study finds strong support for the Technology Acceptance Model in the context of Internet Tools such as E-mail and the WWW. The model is unperturbed by the gender or age of the respondents as well as by their level of computer experience or the task they used the tool for. Given the inconclusive findings of prior studies, this research proves that TAM is still a valuable theoretical model that is especially relevant to Internet technologies.



Note: *p < .05, **p < .01, ***p < .001

Figure 3. TAM for the WWW (Time Spent per Day)
(Fit Indices: χ^2/df = 1.85, prob > χ^2 = 0.0001, GFI = .937, NNI = .981, NFI = .967)

Implications from this study can be categorized as: (1) implications for academia, (2) implications for practitioners, and (3) implications for research. In terms of effects in the academic setting, it is important to teach students how to effectively use Internet tools and reap their full benefits. In order to accomplish this task, perhaps seminars or even an entire course could be devoted to teaching students about Interent tools from the ground up. In these seminars or course, students would be taught how to use the E-mail and the WWW effectively—e.g., learning how to use different search engines, how to find various types of

Table 1. TAM Structural Equation Models for E-mail

Model (Usage is measured as time spent per day)	PEOU → Attitude	PU → Attitude	Attitude → Usage	χ^2/df	prob > χ^2	GFI	NNI	NFI
Males (n=185)	.45***	.37***	.30***	1.84	.0001	.889	.954	.920
Females (n=164)	.33***	.27***	.20**	1.70	.0001	.884	.952	.910
Less than 20 years old in age (n=203)	.32***	.36***	.20**	1.50	.0017	.912	.971	.932
More than 20 years old in age (n=146)	.53***	.25**	.33***	1.56	.0006	.891	.961	.917
Less than 3 years of computer experience (n=112)	.41***	.24**	.19*	1.31	.0200	.873	.966	.892
More than 3 years of computer experience (n=233)	.41***	.38**	.27***	1.61	.0003	.922	.972	.941
Social communication tasks (n=327)	.38***	.35***	.25***	1.77	.0001	.938	.974	.952
Educational tasks (n=293)	.37***	.37***	.25***	1.77	.0001	.933	.971	.947
Model (Usage is measure as how often used)	**PEOU → Attitude**	**PU → Attitude**	**Attitude → Usage**	**χ^2/df**	**prob > χ^2**	**GFI**	**NNI**	**NFI**
Males (n=185)	.45***	.37***	.35***	2.02	.0001	.879	.944	.912
Females (n=164)	.33***	.27**	.24**	1.82	.0001	.870	.944	.904
Less than 20 years old in age (n=203)	.32***	.36***	.25**	1.73	.0001	.899	.959	.923
More than 20 years old in age (n=146)	.53***	.25**	.35***	1.69	.0001	.883	.953	.911
Less than 3 years of computer experience (n=112)	.41***	.24**	.35*	1.41	.0074	.865	.956	.885
More than 3 years of computer experience (n=233)	.41***	.38***	.28***	1.67	.0001	.917	.969	.939
Social communication tasks (n=327)	.38***	.35***	.27***	1.98	.0001	.927	.967	.946
Educational tasks (n=293)	.37***	.37***	.33***	1.84	.0001	.929	.969	.945

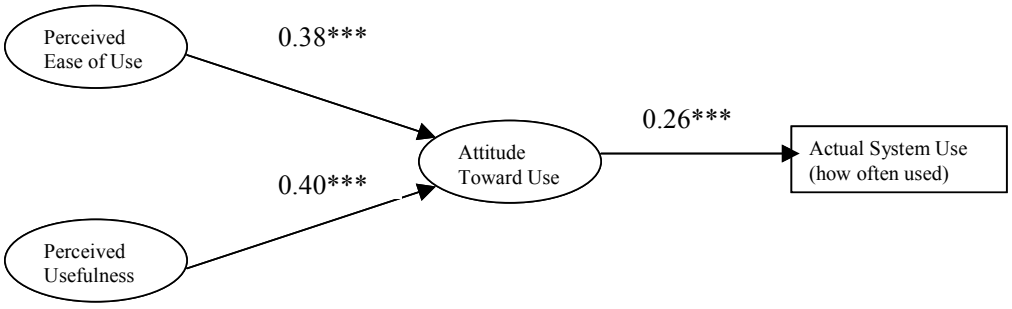
Note: *p < .05, ** p < .01, *** p < .001

Table 2. TAM Structural Equation Models for the WWW

Model (Usage is measured as time spent per day)	PEOU → Attitude	PU → Attitude	Attitude → Usage	χ^2/df	prob > χ^2	GFI	NNI	NFI
Males (n=185)	.41***	.41***	.25*	1.49	.0020	.910	.977	.944
Females (n=164)	.32***	.40***	.24**	1.71	.0001	.889	.967	.937
Less than 20 years old in age (n=203)	.30***	.46***	.18*	1.39	.0091	.925	.983	.952
More than 20 years old in age (n=146)	.46***	.32***	.34***	1.53	.0010	.882	.974	.942
Less than 3 years of computer experience (n=112)	.54***	.33**	.18*	1.63	.0002	.858	.959	.917
More than 3 years of computer experience (n=233)	.28***	.44***	.30**	1.45	.0038	.931	.984	.958
Social communication tasks (n=327)	.36***	.39***	.25***	1.69	.0001	.942	.983	.966
Educational tasks (n=293)	.41***	.34***	.27**	1.77	.0001	.932	.980	.962
Model (Usage is measured as how often used)	**PEOU → Attitude**	**PU → Attitude**	**Attitude → Usage**	**χ^2/df**	**prob > χ^2**	**GFI**	**NNI**	**NFI**
Males (n=185)	.45***	.41***	.56***	1.51	.0015	.908	.977	.946
Females (n=164)	.32***	.40***	.26**	1.74	.0001	.887	.966	.936
Less than 20 years old in age (n=203)	.34***	.46***	.46***	1.41	.0070	.922	.983	.954
More than 20 years old in age (n=146)	.46***	.32***	.46***	1.60	.0003	.877	.971	.940
Less than 3 years of computer experience (n=112)	.57***	.33**	.37***	1.61	.0003	.861	.962	.921
More than 3 years of computer experience (n=233)	.28***	.43***	.48***	1.59	.0004	.894	.979	.954
Social communication tasks (n=327)	.38***	.39***	.44***	1.80	.0001	.936	.981	.965
Educational tasks (n=293)	.44***	.33***	.49***	1.91	.0001	.926	.977	.961

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

information, how to use E-mail on the Web, etc. Also, other advanced features could be taught such as utilization of chat rooms, etc. But in order to make the most impact in a student's academic career in terms of awareness, attitude, and usage towards Internet tools, these seminars or course should be taught at an early stage-perhaps as early as the first semester in the freshman year.



Note: *p < .05, **p < .01, ***p < .001

Figure 4. TAM for the WWW (How Often Used)
(Fit Indices: χ^2/df = 1.76, prob > χ^2 = 0.0001, GFI = .941, NNI = .983, NFI = .968)

With respect to effects in the business environment—especially electronic commerce— the Internet is making a strong impact. Today, with the explosion of the WWW, many companies are marketing their products and services on-line. For example, one can purchase a computer on-line, and even make airline reservations and purchase "electronic" tickets (e-tickets) over the Web. For these companies, the components of perceived ease of use and perceived usefulness are very important. For example, it will be crucial for these companies to make their websites easy to use - so that customers can navigate around the website with no difficulty to find the products and services they desire. In terms of usefulness, customers should also feel satisfied that their needs and wants have been fulfilled by purchasing over the Web, which will lead to increased repeat business for these companies which market over the Web.

Finally, in terms of future academic research into TAM, previous research works have focused upon the utilization of other software tools and very few have focused upon Internet tools. But, due to the explosion of the Web, there will no doubt be a lot of research conducted in this area. It will probably be TAM which will be the model of choice because of its heavy use and validation in previous research works.

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