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ACCEPTANCE OF TECHNOLOGY WITH NETWORK EXTERNALITIES: AN EMPIRICAL STUDY OF INTERNET INSTANT MESSAGING SERVICES

CHIH-CHIEN WANG, National Taipei University
Graduate Institute of Information Management, College of Business, P.O. Box 179-45, Taipei City 116. Taiwan, Email: wangson@mail.ntpu.edu.tw

YAHUI HSU, National Taipei University
Department of Business Administration, College of Business, Email: ryahui_hsu@msn.com

WENCHANG FANG, National Taipei University
Department of Business Administration, College of Business, Email: fang@mail.ntpu.edu.tw

ABSTRACT

Many researchers have examined the technology acceptance model (TAM) that Davis (1986) created to predict the voluntary use of information systems. However, TAM's primary focus is on how ease of use and usefulness influence acceptance, without looking at the effects of network externalities. In this study, we examined adoption behavior involving Internet-based instant messaging services (IMS). A questionnaire was used to collect data on perceived usefulness, perceived ease of use, perceived number of users for external network utility, and technology utility. The results indicate an acceptable goodness-of-fit statistic for our proposed TAM model, which combines the original TAM concept and network externality theory. The results also support the importance of network externalities in considering IT acceptance.

INTRODUCTION

The success of any information systems development depends on a combination of user acceptance and advancements in technology. Davis's (1986, 1989) technology acceptance model (TAM) is one of the best-known approaches to explaining and predicting user acceptance of information systems. According to Davis, perceived usefulness (PU) and

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perceived ease of use (PEOU) are the two most important factors determining system usage. He defined PU as the degree to which a person believes that using a particular information system will enhance his or her job performance (Davis 1989); PEOU was defined as "the degree to which a person believes that using a particular information system would be free of effort." The TAM approach assumes that PU is influenced by PEOU -- that is, systems that are perceived as easier to use are also perceived as being more useful (Venkatesh & Davis 2000).

A long list of researchers have used various technologies to test, assess, and verify TAM, which included Adams, Nelson and Todd (1992), Agarwal and Prasad (1997), Bhattacherjee (2000), Chau (1996), Chau and Hu (2001), Chen and Lou (2002), Chin and Todd (1995), Davis (1989), Davis, Bagozzi, and Warshaw (1989), Doll, Hendrickson and Deng (1998), Gefen and Straub (1997), Hong, Thong, Wong and Tam (2001), Hu and Chau (1999), Lucas and Spitler (1999), Mathieson (1991), Moon and Kim (2001), Szajna (1994), Venkatesh and Davis (2000), Venkatesh, Speier, and Morris (2002), and Wober and Gretzel (2000) and some others. The technologies used to test the effectiveness of TAM include email, voice mail, word processors, spreadsheets, database programs, graphic systems, decision support systems, and the World-Wide Web browsers. In the majority of these studies, use of the TAM model was supported by the empirical results.

However, there are other factors that influence behavioral intention to use (BI) and actual usage behavior (AB)--for instance,

CONTRIBUTION

Few researchers have looked at instant messaging service (IMS) adoption and acceptance, especially the effect of network externality on IMS acceptance. The issue is important because IMS software that possesses network externality is positioned to become a globally accepted interpersonal communications technology.

In this paper, we combine the technology acceptance model (TAM) with network externality to examine IMS user acceptance. We added two constructs to perceived usefulness (PU) and perceived ease of use (PEOU) in order to analyze the influence of network externality on technology acceptance: technology utility (TU) to represent a standalone utility and perceived number of users (PNOU) to represent a network externality utility. Our results show that the combination of the original TAM with network externality was useful to explain the acceptance of technology in the presence of network externality.

We believe this paper makes at least three contributions to the literature on this topic: First, we found that TAM could be used to explain the adoption of IMS. Second, our study provided as an evidence for the existence of network externality and the influence of network externality to the acceptance of IMS. It might be an important contribution since that most papers in the topic of network externality are conceptual and empirical studies have been done. Finally, this study found that it is necessary to combine the network externality variables into TAM when discussing the adoption of technology in the presence of network externality.

To practitioners, this study pointed out the importance of raising ease of use and increasing the user base to the intention of using IMS. In keeping with the overall goal of increasing the number of IMS users, our focus was to help IMS firms identify potential users based on perceived ease of use, perceived usefulness, technology utility, and perceived number of users. Potential users can be targeted via a marketing campaign that emphasizes the value of IMS to adopters (ease of use and usefulness), provides the required tools to learn how to use the service correctly (behavioral intention to use), and provides information on IMS itself (technology utility) and number of users (network externality).

Although this study was conducted within the IMS context, we believe the results are applicable to other communication-based IT services with network externalities--for instance, telephone service firms and bulletin board system services.

perceived utility from a network externality effect. According to Rohlfs (1974) and Katz and Shapiro (1985), network externality is the characteristic of change in product value according to the number of users. In short, the utility that a user derives from consuming a good or product increases as the number of consumers of the same good or product also increases (Katz & Shapiro 1986).

Communication products serve as one example of merchandise for which network externality strongly influences user utility. Internet-based Instant Messaging Services (IMSs) are relatively recent communication products that possess network externality. User acceptance of an IMS may be determined not only by perceived usefulness or ease of use, but also by the network effect based on the number of users. According to marketing research conducted by Jupiter Media Metrix, 53.8 million Americans used an instant messaging product in their home at least once during September, 2001, an increase of 28 percent compared to September, 2000. A smaller but still significant number of Americans (13.4 million) used instant messaging at work during September of 2001 (Denison, 2002).

The adoption behavior of IMS users is the primary focus of this study. The main research questions are (a.) can IMS be used to reconfirm the usefulness of TAM to explain or predict acceptance of an IS product? and (b.) can the combination of the TAM approach and network externality be used to explain and/or predict the adoption of IMS?

RESEARCH HYPOTHESES

TAM

To develop his TAM model, Davis (1989) incorporated features of theory of reasoned action (TRA), which had previously been used to explain and predict a broad range of behaviors such as choosing a career and voting for a presidential candidate (see also Davis, 1989 and Davis, Bagozzi & Warshaw, 1989). The literature contains considerable evidence showing a strong link between perceived ease of use (PEOU) and behavioral intention to use (BI). Furthermore, perceived usefulness (PU) is considered a significant predictor of BI, PEOU is thought to exert a significant influence on PU, and both PU and PEOU influence an individual's behavioral intention to use a new system (Fliegel & Kivlin 1966; Ostlund 1974; Szajna 1996; Tornatzky & Klein 1982; Zaltman, Duncan & Holbek 1973). PU and PEOU are therefore believed to be useful as predictive tools. At least two studies have shown that BI also influences actual usage behavior (AB) (Davis, Bagozzi & Warshaw 1989; Szajna 1996).

Four of the most important concepts that have been repeatedly discussed in the TAM literature are perceived ease of use, perceived usefulness, behavioral intention and actual usage behavior. The perceived usefulness of a technology increases with perceived ease of use. The more useful and simple (ease of use) a user thinks a new technology is, the stronger his or her intention to use the system; furthermore, the stronger the usage intention, the greater the actual usage behavior. Based on this background, the first four hypotheses were established as

H1: Perceived ease of IMS use positively and directly influences perceived IMS usefulness.

H2: Perceived IMS usefulness positively and directly influences behavioral intention to use IMS.

H3: Perceived ease of IMS use positively and directly influences behavioral intention to use IMS.

H4: Behavioral intention to use IMS positively and directly influences actual IMS usage.

Technology Utility

Technology utility (TU) is standalone utility which is unrelated to user size and used to describe utility not arising from the network externality effect (Farrell & Saloner 1986; Kauffman, McAndrews & Wang 2000; Saloner & Shepard 1995). Occasionally, an older product with a large user base is pushed out of a market and replaced with a new product that has greater technological utility. The new product is often successful due to a unique design feature or function. IMS has a considerable TU because it would exist regardless of the level of adoption by other

users. The primary IMS function--instant information exchange among users--determines its technological utility.

Through the increase of customers' perceived technology valuation, technological utility can influence user perceptions of usefulness and intention to use (Kauffman, McAndrews & Wang 2000). In the IMS example, users may regard a particular IMS as being especially useful because it has functions that are not available from other IMS types--e.g., allowing for interactions among a large group of message-sharers, the ability to exchange large files, or the ability to deliver high quality audio or images. These kinds of features may increase intention to use. Individuals making a choice among several types of IMS software should consider the standalone utility of the technology and the network effect utility associated with the number of current users. Based on the assumption that the perceived usefulness and behavioral intention of IMS increases with its technology utility, we established the next two hypotheses as

H5: Technology utility positively and directly influences perceived IMS usefulness.

H6: Technology utility positively and directly influences behavioral intention to use the IMS.

Network Externality

Rohlfs (1974) and Katz and Shapiro (1985) proposed and developed the network externality concept to explain the phenomenon that perception of product utility is tied to the number of product users. Essentially, network externalities occur when the perceived benefit of using a product increases with the perceived number of users (PNOU) of that product. In this study, we were less concerned with actual user numbers than with user perceptions of the number of people adopting IMS. Accordingly, we established the next hypothesis as

H7: The perceived number of IMS users positively and directly influences perceived IMS usefulness.

The perceived number of users can affect technology acceptance by altering users' perceived ease of use. The perception of a large number of IMS users may encourage IMS adopters to take the necessary time to learn about a specific program's features and functionalities, to get hands-on experience, or to ask for demonstrations from other IMS users. As more time is spent exchanging information, IMS adopters will increasingly accept the attitude that IMS is not difficult to learn or use, and they will likely share that perception with other potential users (Lou, Luo & Strong 2000). Accordingly, the next hypothesis was established as

H8: Perceived number of IMS users positively and directly influences perceived ease of use.

Lou, Luo and Strong (2000) have argued that information system acceptance requires the participation of many individuals to create a sense of collective action. Few people are willing to use technology on their own or in small numbers; when it comes to IT, there is a strong perception of safety in numbers (Shapiro & Varian, 1998). Pae and Hyun (2002) recently offered evidence showing that network externality is positively associated with technology adoption, and that consumers value compatibility because it gives them access to larger networks. Chakravarty (2003) found that over 80 percent of technology buyers do so in anticipation that other buyers will buy the same technology in the future, even though it may be more expensive. Additional support for the idea that behavioral intention and adoption behavior is influenced by network externalities comes from Lange, McDade and Oliva (2004). Based on this background, our final hypothesis is

H9: The perceived number of IMS users positively and directly influences behavioral intention to use IMS.

An illustration of our proposed modification of the TAM model is shown in Figure 1.

METHODOLOGY

Instrument Development and Data Collection

A questionnaire survey was constructed and used to examine the effects of network externality and TAM on IMS behavioral

intention and actual usage. Specifically, the collected data were used to determine the effectiveness of PEOU, PU, and BI as predictors of AB. PEOU and PU attributes were measured using modified multiple-item perceptual scales from Davis (1989) and Venkatesh and Davis (2000). Four BI items were used to assess the behavioral intentions of respondents who had downloaded and installed IMS software, or whose computers already had IMS software installed.

All responses were measured along a Likert-type scale, with 1 ="strongly disagree," 4 = "neutral," and 7 = "strongly agree." AB was assessed with two items that were designed to measure the respondents' IMS usage. TU and PNOU were individually assessed with three items each. Respondents were asked to assess IMS in terms of technical usefulness and value in order to examine the TU construct. The PNOU items were designed to measure the number of IMS users. The questionnaire also collected demographic data. The scales are presented in an appendix to this paper.

The survey was pre-tested with 30 students from a university in northern Taiwan to assess the scales' psychometric attributes. Several items were modified based on their responses and comments.

A convenience sampling approach was used to verify the hypotheses. According to research published by the Taiwan Network Information Center (TWNIC) in July of 2003, the largest numbers of computer network users in that country are in the 16-20 (1.62 million) and 21-25 (1.86 million) age segments. The large majority of users in these age brackets are high school and college students, which supports our decision to create an entire sample consisting of student volunteers from several Taiwanese colleges.

The questionnaire was administered to 517 students; 437 (84.53%) fully completed questionnaires were accepted for data analysis (283 female, 154 male). Respondent ages ranged from 17 to 33; only 10 stated that they had no experience using an IMS program. The most frequently used IMS services were MSN Messenger (85%), Yahoo Messenger (67%) and ICQ (13%); these figures indicate that many respondents were familiar with more than one IMS service.

Reliabilities and Validation

Cronbach alphas were calculated with SAS software in order to measure the reliability of the six constructs (see Hair, Anderson, Tatham and Black 1998, for a detailed description of the Cronbach alpha formula). We calculated Cronbach alphas of 0.91, 0.89, 0.94, 0.95, 0.84 and 0.80 for the PEOU, PU, BI, AB, TU and PNOU scales, respectively, thus confirming their individual reliability. All of the reliabilities exceeded 0.70, well within the commonly accepted range (Gefen, Straub & Boudreau 2000) (Table 1).

Since all data were collected at the same time using the same instrument, we needed to address the potential for common

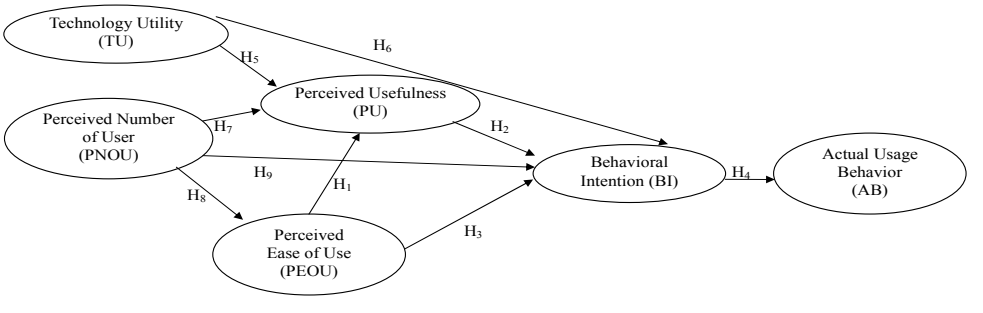

Figure 1. Proposed model

method variance (Gefen, Karahanna & Straub 2003; Straub, Limayem & Karahanna 1995; Woszczynski & Whitman 2004); we therefore made use of Harmon's one-factor test (Igbaria, Zinatelli, Cragg & Cavaye 1997; Podsakoff & Organ 1986). We performed an exploratory factor analysis of all 20 items in our survey and extracted four factors with eigenvalues greater than 1. Just under three-fourths (72.38%) of all variance was explained by these four factors; one factor accounted for 49.08 percent. We therefore concluded that common method variance did not affect the data.

Convergent validity is assessed by reviewing a measurement model's factor loading (Anderson & Gerbing 1988). Convergent validity is assumed if the factor loadings for all indicators measuring the same construct are statistically significant. As shown in Figures 2 and 3, all factor loadings in this research were identified as significant.

Discriminant validity addresses the degree to which measures of different variables are unique (Bagozzi, 1982). This is achieved when correlations between any two latent variables are found to be significantly different from unity, i. e. significantly less than 1.00 (Bagozzi, Yi & Phillips 1991; Segars & Grover 1998). Correlations among TU, PNOU, PEOU and PU are listed in Table 2. The confidence intervals of the correlations show that the values were significantly less than unity (1.00), thus confirming discriminant validity.

DATA ANALYSIS

Structural equation modeling (SEM) was used to identify factors and to measure the influences of the TU and PNOU exogenous variables on the PEOU, PU, BI and AB endogenous variables. SEM is a confirmatory approach to data analysis that requires a priori assignments of inter-variable relationships. It consists of statistical tests of a hypothesized model to determine consistency between the model and sample data. SEM provides an assessment of predictive validity, specifies direct and indirect relations among latent variables, and quantifies explained and unexplained variance in a model (Byrne 1998; Schumacker & Lomax 1996; Wisner 2003). We used it to test our proposed model and to develop a new model based on the best data fit (Rosen-Grandon, Myers & Hattie 2004).

SEM does not offer a single test of significance for absolutely identifying a correct model given sample data (Schumacker & Lomax 1996). Since several goodness-of-fit criteria have been established, some researchers recommend presenting more than one index to assess model fit (see, for example, Bentler 1992 and Garver & Mentzer 1999).

Before analyzing our proposed model, we analyzed the normality assumption of SEM and got the results that Skewness was calculated at -1.38 and Kurtosis 1.33; standardized Z values were -11.78 and 5.68, both significant at $p<0.05$. We chose SAS/CALIS to analyze our proposed model.

TAM

First, the original TAM model for IMS was examined. The SEM analysis indicated acceptable model fit. According to Gefen, Straub, and Boudreau (2000), and Hair, Anderson, Tatham, and Black (1998), goodness of fit index (GFI), comparative fit

Table 1. Composite Construct Reliabilities

Construct	Reliabilities
Perceived ease of use (PEOU)	0.91
Perceived Usefulness (PU)	0.89
Behavioral intention to use (BI)	0.94
Actual usage behavior (AB)	0.95
Technology Utility (TU)	0.84
Perceived number of users (PNOU)	0.80

Table 2. Correlations among Latent Variables for Discriminant Validity Tests

	TU	PNOU	PEOU
PNOU	0.424(0.049)		
PEOU	0.528(0.041)	0.729(0.031)	
PU	0.542(0.041)	0.522(0.044)	0.549(0.038)

Note: Numbers in parentheses represent standard errors. All differences from unity were statistically significant at p<0.05.

index (CFI), normed fit index (NFI), and non-normed fit index (NNFI) are best if above 0.90 and demonstrate marginally acceptance if above 0.80, adjusted goodness of fit index (AGFI) above 0.80, root mean square residual (RMR) below 0.05. Jiang, Klein, and Carr (2002) also recommended the ratio of χ^2 to degrees of freedom below 5. The GFI of this model was 0.94, AGFI was 0.90, RMR was 0.04, CFI was 0.97, NFI was 0.96, NNFI was 0.96 and χ^2 to degrees of freedom ratio of 3.23 ($\chi^2_{69} = 223.29$), all within the accepted thresholds. Figure 2 illustrated the results of SEM analysis. The proposed model states that BI was influenced by PU and PEOU, and that PEOU exerts an indirect effect on BI. All model paths were significant at p<0.05.

Network Externality

Farrell and Saloner (1986) noted that the value of a product with network externalities comprised the standalone benefit (i.e. TU in this study) and the perceived size of the network (i.e. PNOU in this study). This study followed this point and examined the network externality. The SEM analysis showed acceptable model fit. The GFI was 0.95, AGFI was 0.91, CFI was 0.97, NFI was 0.95, NNFI was 0.95, and χ^2 to degrees of freedom ratio is 3.79 ($\chi^2_{31} = 117.41$), all within the accepted thresholds. Figure 3 summarized the results of SEM analysis. The model demonstrated that PU was influenced by TU and PNOU. All paths in the model were significant at p<0.05.

Extended TAM

We examined three extended technology acceptance models for IMS. Model 1 focused on the direct effect only, model 2 on the mediation effect, and model 3 on a combination of the direct and mediation effects. Furthermore, model 1 was limited to the direct effect of TU on BI and of PNOU on BI; model 2 was limited to the mediation effect of TU on BI via PU, and of PNOU on BI via PEOU and PU.

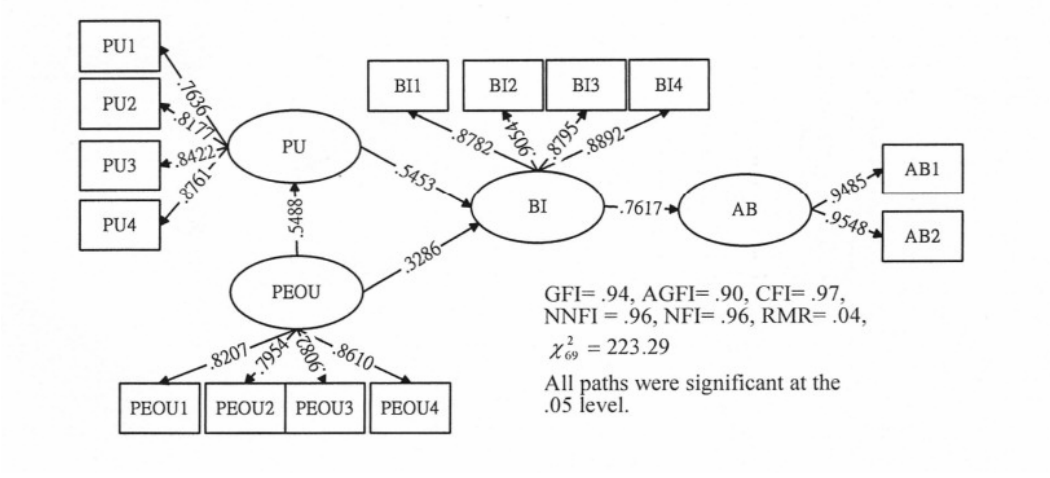

Figure 2. SEM analysis results

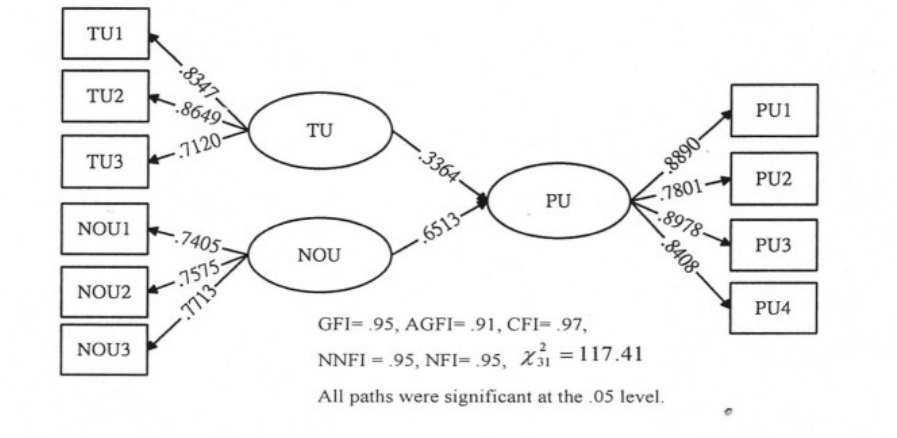

Figure 3. SEM analysis results for network externality

Our SEM analysis revealed an acceptable fit for model 1, with an AGFI of 0.83, CFI 0.93, NFI 0.91, NNFI 0.91, and a ratio of χ^2 to degrees of freedom of 4.12 ($\chi^2_{159} = 655.34$)--all within acceptable thresholds (Fig. 4). The 0.87 GFI was below 0.90 but well above the 0.80 acceptance benchmark. According to Boudreau, Gefen and Straub (2001), SEM models seldom show excellent fit values for all indices--even those reported in the leading MIS journals. We therefore suggest that model 1 has an acceptable fit. All paths for all of the three tested models were significant at p<0.05.

An acceptable fit was also determined for models 2 and 3.The values for model 2 were GFI 0.90, AGFI 0.86, CFI 0.94, NFI 0.92, NNFI 0.93, and ratio of χ^2 to degrees of freedom of 1:3.78 ($\chi^2_{159} = 537.38$)(Fig. 5). For model 3 the values were GFI 0.90, AGFI 0.87, CFI 0.95, NFI 0.93, NNFI 0.94, and a 1:3.26 ratio of χ^2 to degrees of freedom ($\chi^2_{158} = 514.88$). The values for models 2 and 3 were all within acceptable thresholds (Fig. 6).

Data on the goodness-of-fit indices for the three models are shown in Table 3. They indicate that model 3--referring to the existence of both direct and mediated effect between TU and BI and between PNOU and BI--had the best goodness-of-fit of the three. Furthermore, the results indicate the feasibility of combining the original TAM with a network externality model.

All of the nine research hypotheses were accepted. The results support H1 (perceived ease of use positively and directly influences perceived IMS usefulness) and H2 (perceived usefulness positively and directly influences behavioral intention to use IMS). They also give strong support to H3 (perceived ease of IMS use positively and directly influences behavioral intention to use IMS) and confirmed H4 (behavioral intention to use IMS positively and directly influences actual IMS usage). Both H5 and H6 were supported by the data, indicating that technology utility positively and directly influences perceived IMS usefulness and behavioral intention to use IMS. Support was also found for H7, H8 and H9--that is, the perceived number of IMS users positively and directly influences perceived usefulness, perceived ease of use, and behavioral intention to use.

DISCUSSION

The main purpose of this study was to examine the goodness-of-fit of a proposed model that combines Davis's (1986) original TAM and network externality theory to clarify user acceptance of IMS. Nine research hypotheses were formulated and tested using data collected via a questionnaire survey. SEM tests were used to examine the goodness-of-fit of the revised TAM; test results showed an acceptable model fit in all cases, with all model paths significant at p<0.05. The data showed that (a.) TU directly and positively influenced

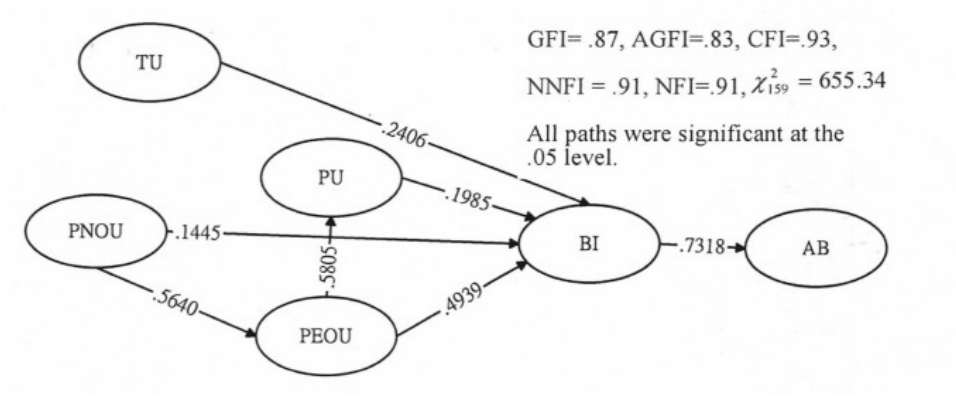

Figure 4. SEM analysis results for Model 1.

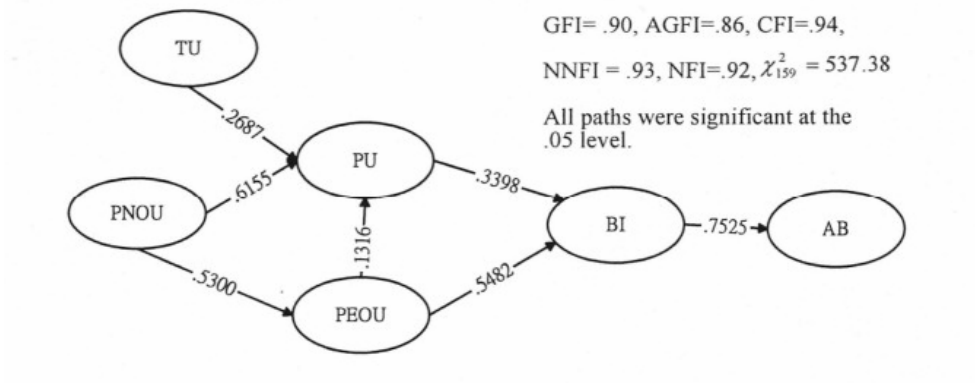

Figure 5. SEM analysis results for Model 2

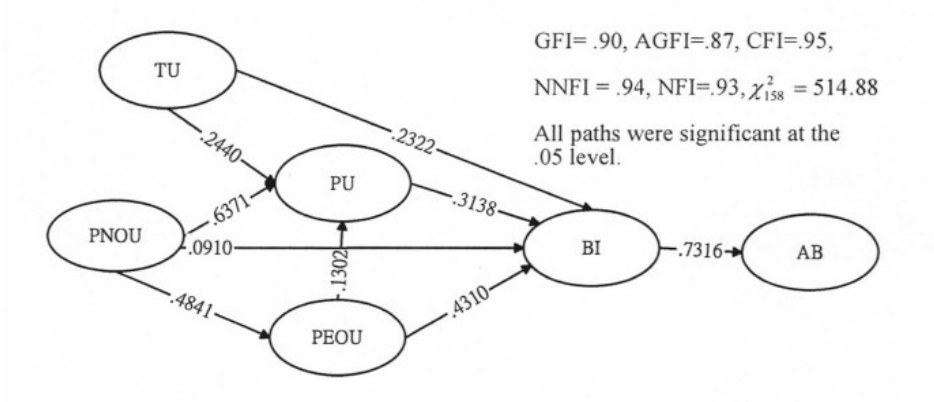

Figure 6. SEM analysis results for Model 3

Table 3. Goodness-of-fit Statistics for the Various Models

	Goodness-of-fit							
Model Description	*GFI*	*AGFI*	*CFI*	*NFI*	*NNFI*	χ^2	*d.f.*	$\chi^2/d.f.$
Model 1 (direct effect only)	0.8732	0.8325	0.9272	0.9065	0.9130	655.34	159	4.12
Model 2 (mediation effect only)	0.8975	0.8646	0.9445	0.9233	0.9337	537.38	159	3.78
Model 3 (direct + mediation effect)	0.9000	0.8671	0.9477	0.9266	0.9371	514.88	158	3.26

PU and BI and indirectly affected BI through PU; (b.) PNOU directly and positively influenced PU, PEOU and BI, indirectly affected PU through PEOU, and indirectly affected BI through PEOU and PU; (c.) PEOU directly and positively influenced PU and BI and indirectly influenced BI through PU; and (d.) BI directly and positively influenced AB. These results suggest a successful integration of the original TAM with a network externality model.

This study represents a careful and systematic effort to build a model describing adoption behavior and test it with IMS as the target product. The research hypotheses were designed to be more illustrative than exhaustive, and to stimulate further research in this area. To our knowledge, no researchers to date have used IMS to study technology adoption and acceptance, nor examined the effect of network externality on IMS acceptance.

Since our hypotheses were rooted in TAM and network externality theory (both applicable to goods, services, concepts, and ideas), we believe that they would also hold true for other IT products and services. Additional studies are required to validate our results. Future researchers may also be interested in determining whether or not our conclusions are true for America Online (AOL), the largest IMS provider in the U.S.

Our data was collected via convenience samples. This constraint blocks the potential for generalizing our findings. Future researchers may want to use random sampling techniques to obtain representative data.

REFERENCES

Adams, D. A., Nelson, R. R. and P. A. Todd, "Perceived usefulness, ease of use, and usage of information technology: a replication," *MIS Quarterly*, 1992, 16:2, pp. 227-247.

Agarwal, R. and J. Prasad, "The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies," *Decision Sciences*, 1997, 28:3, pp. 557-582.

Ahire, S. L, Golhar, D. Y. and M. A. Waller, "Development and validation of TQM implementation constructs," *Decision Sciences*, 1996, 27:1, pp. 23-56.

Allen, D., "New telecommunications services: network externalities and critical mass," *Telecommunications Policy*, 1998, 12:3, pp. 257-271.

Anderson, J. C. and D. W. Gerbing, "Structural equation modeling in practice: A review and recommended two-step approach," *Psychological Bulletin*, 1988, 103:3, pp. 411-423.

Bagozzi, R. P., *An examination of the validity of two models of attitude*, in C. Fornell (eds.), A Second Generation of Multivariate Analysis, Volume 2: Measurement and Evaluation, Praeger, 1982, pp. 145-184.

Bagozzi, R. P., Yi, Y., and L. W. Phillips, "Assessing construct validity in organizational research," *Administrative Science Quarterly*, 1991, 36:3, pp. 421-459.

Bentler, P. M., "On the fit of models to covariances and methodology of to the bulletin," *Psychological Bulletin*, 1992, 112:3, pp. 400-404.

Bhattacherjee, A., "Understanding information systems continuance: an expectation-confirmation model," *MIS Quarterly*, 2001, 25:3, pp. 351-370.

Boudreau, M., Gefen, D. and D. W. Straub, "Validation in IS research: A state-of-the-art assessment," *MIS Quarterly*, 2001, 25:3, pp. 1-16.

Byrne, B., *Structural Equation Modeling with Lisrel, Prelis, and Simplis: Basic Concepts, Applications, and Programming*, New Jersey: Lawrence Erlbaum Associates, 1998.

Chakravarty S., "Experimental evidence on product adoption in the presence of network externalities," *Review of Industrial Organization*, 2003, 23:3-4, pp. 233.

Chau, P. Y. K., and P. J. H. Hu, "Information technology acceptance by individual professionals: a model comparison approach," *Decision Sciences*, 2001, 32:4, pp. 699-713.

Chau, P. Y. K., "An empirical assessment of a modified technology acceptance model," *Journal of Management Information Systems*, 1996, 13:2, pp. 185-204.

Chen, Y. and H. Lou, "Toward an understanding of the behavioral intention to use a groupware application," *Journal of Organizational and End User Computing*, 2002, 14:4, pp. 1-16.

Chin, W. and P. A. Todd, "On the use, usefulness, and ease of use of structural equation modeling in MIS research: A Note of Caution," *MIS Quarterly*, 1995*,* 19:2, pp. 237-246.

Davis, F. D., "A technology acceptance model for empirically testing new end-user information systems: theory and results," *Doctoral Dissertation, Sloan School of Management, Massachusetts Institute of Technology*, 1986*.*

Davis, F. D., "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly*, 1989, 13:3, pp. 319-340.

Davis, F. D., Bagozzi, R. P. and P. R. Warshaw, "User acceptance of computer technology: a comparison of two theoretical models," *Management Science*, 1989, 35:8, pp. 982-1003.

Denison, D. C., "Instant messaging highlights unpredictability of business technologies," *Knight Ridder Tribune Business News,* Washington, March 25, 2002, pp. 1.

Doll, W. J., Hendrickson, A., and X. Deng, "Using Davis's perceived usefulness and ease-of-use instruments for decision making: a confirmatory and multi-group invariance analysis," *Decision Sciences*, 1998, 29:4, pp. 839-869.

Farrell, J. and G. Saloner, "Installed base and compatibility: innovation, product preannouncements, and predation," *American Economical Review*, 1986, 76:5, pp. 940-955.

Fliegel, F. C. and J. E. Kivlin, "Attributes of innovations as factors in diffusion," *The American Journal of Sociology*, 1966, 72, pp. 235–248.

Garver, M. and J. T. Mentzer, "Logistics research methods: employing structural equation modeling to test for construct validity," *Journal of Business Logistics*, 1999, 20:1, pp. 33-58.

Gefen, D., Karahanna, E., and D. W. Straub, "Trust and TAM in online shopping: an integrated model," *MIS Quarterly*, 2003, 27:1, pp. 51-90.

Gefen, D. and D. W. Straub, "Gender differences in the perception and use of e-mail: an extension to the technology acceptance model," *MIS Quarterly*, 1997, 21:4, pp. 389-400.

Gefen, D., Straub, D. W., and M. C. Boudreau, "Structural equation modeling and regression: guidelines for research practice." *Communications of the Association for Information Systems*, 2000, 4:7, pp. 1-70.

Hair, J. F. J., Anderson, R. E., Tatham, R. L., and W. C. Black, *Multivariate Data Analysis with Readings* (5th Ed.), Englewood Cliffs, NJ: Prentice Hall, 1998.

Hatcher, L., *A step-by-step approach to using the SAS system for factor analysis and structural equation modeling*, Cary, NC: SAS Institute.

Hong, W., Thong, J. Y. L., Wong, W. M. and K.Y. Tam, "Determinants of user acceptance of digital libraries: an empirical examination of individual differences and systems characteristics," *Journal of Management Information Systems,* 2001, 18:3, pp. 97-114.

Hu, P. J., and P. Y. K. Chau, "Examining the technology acceptance model using physician acceptance of telemedicine," *Journal of Management Information Systems*, 1999, 16:2, pp. 91-104.

Igbaria, M., Zinatelli, N., Cragg, P., and A. L. M. Cavaye, "Personal computing acceptance factors in small firms: a structural equation model," *MIS Quarterly*, 1997, 21:3, pp. 279–302.

Jiang, J. J., Klein, G. and C. L. Carr, "Measuring information system service quality: SERVQUAL from the other side," *MIS Quarterly*, 2002, 26:2, pp. 145-166.

Katz, M. L. and C. Shapiro, "Network externalities, competition, and compatibility," *The American Economic Review*, 1985, 75:3, pp. 424-440.

Katz, M. L. and C. Shapiro, "Product compatibility choice in a market with technological progress," *Oxford Economics Papers*, 1986, 38, pp. 146-169.

Kauffman, R. J., McAndrews J. and Y-M Wang, "Opening the "black box" of network externalities in network adoption," *Information Systems Research*, 2000, 11:1, pp. 61-82.

Lange, R., McDade, S. R. and T. A. Oliva, "The estimation of a cusp model to describe the adoption of word for windows," *The Journal of Product Innovation Management*, 2004, 21:1, pp. 15.

Lou, H., Luo, W. and D. Strong, "Perceived critical mass effect on groupware acceptance," *European Journal of Information Systems*, 2001, 9:2, pp. 91-103.

Lucas, H. C. and V. K. Spitler, "Technology use and performance: a field study of broker workstations," *Decision Sciences*, 1999, 30:2, pp. 291-311.

Mathieson, K., "Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior," *Information Systems Research*, 1991, 2:3, pp. 173-191.

Moon, J. W. and Y. G. Kim, "Extending the TAM for a world-wide-web context," *Information & Management*, 2001, 38:4, pp. 217-230.

Ostlund, L. E., "Perceived innovation attributes as predictors of innovativeness," *Journal of Consumer Research,* 1974, 1, pp. 23-29.

Podsakoff, P. M., and D. W. Organ, "Self-reports in organizational research: problems and prospects," *Journal of Management*, 1986, 12:4, pp. 531–544.

Rohlfs, J., "A Theory of Interdependent Demand for a Communications Service," *Bell Journal of Economics,* 1974, 5:1, pp. 16-37.

Rosen-Grandon, J. R., Myers, J. E., and J. A. Hattie, "The relationship between marital characteristics, marital interaction processes, and marital satisfaction," *Journal of Counseling and Development*, 2004, 82:1, pp. 58-68.

Saloner, G. and A. Shepard, "Adoption of technologies with network effects: An empirical examination of the adoption of automated teller machines," *The Rand Journal of Economics*, 1995, 26:3, pp. 479-501.

Schumacker, R. and R. Lomax, *A Beginner's Guide to Structural Equation Modeling*, New Jersey: Lawrence Erlbaum and Associates, 1996.

Segars, A. H. and V. Grover, "Strategic information systems planning success: An investigation of the construct and its measurement", *MIS Quarterly*, 1998, 22:2, pp. 139-163.

Shapiro, C. and H. Varian, *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business School Press, 1998.

Straub, D. W., Limayem, M., and E. Karahanna, "Measuring system usage: implications for IS theory testing," *Management Science*, 1995, 41:8, pp. 1328-1342.

Stratma, J. K. and A. V Roth, "Enterprise resource planning (ERP) competence constructs: Two-stage multi-item scale development and validation ," *Decision Sciences*, 2002, 33:4, pp. 601-628.

Szajna, B., "Software evaluation and choice: predictive validation of the technology acceptance instrument,"*MIS Quarterly*, 1994, 18:3, pp. 319-325.

Szajna, B., "Empirical evaluation of the revised technology acceptance model," *Management Science*, 1996, 42:1, pp. 85-92.

Taiwan Network Information Center (TNWIC), *Survey on Broadband Usage in Taiwan 2003- A Summary Analysis*, July 2003.

Tornatzky, L. G. and L. Klein, "Innovation characteristics and innovation implementation: a Meta-Analysis of findings," *IEEE Transactions on Engineering Management*, 1982, 29:1, pp. 28-45.

Venkatesh, V., Speier, C., and M. G. Morris, "User acceptance enablers in individual decision making about technology: toward an integrated model," *Decision Sciences*, 2002, 33:2, pp. 297-316.

Venkatesh, V. and F. D. Davis, "A theoretical extension of the technology acceptance model: four longitudinal field studies," *Management Science*, 2000, 46:2, pp. 186-204.

Wisner, J. D., "A structural equation model of supply chain management strategies and firm performance," *Journal of Business Logistics* , 2003, 24:1, pp. 1-26.

Wober, K. and U. Gretzel, "Tourism managers' adoption of marketing decision support systems," *Journal of Travel Research*, 2000, 39:2, pp. 172-181.

Woszczynski, A., and M. Whitman, "The Problem of Common Method Variance in IS Research," In Whitman, M. and Woszczynski, A. (eds.), *The Handbook of Information Systems Research,* Idea Group Publishing, Hershey, PA, 2004, pp. 66-77.

Zaltman, G., Duncan R. and J. Holbek, *Innovations and Organizations,* John Wiley, New York, 1973.

AUTHORS

Chih-Chien Wang, PhD, is currently assistant professor of information management at the National Taipei University. His research interests include electronic commerce, online consumer behaviour, Internet rumours, e-mail spamming, and the impact of Internet to society.

Ya-Hui Hsu is a PhD student of Department of Business Administration at National Taipei University. She received her MBA degree at National Taipei University in 2003. Her research interests include network externality, IT adoption and usage, and product preannouncement.

Wen-Chang Fang, professor of Department of Business Administration at National Taipei University. He received PhD degree form Northwestern University, USA. His research focuses are mainly on electronic commerce and network externalities. He is now also chief editor for the Electronic Commerce Studies, a quarterly academic journal in Taiwan.

APPENDIX: MEASUREMENT SCALES

Perceived usefulness (PU) and perceived ease of use (PEOU) scales were modifications of those originally established by Davis (1989) and Venkatesh and Davis (2000). The behavioral intention to use (BI), actual usage behavior (AB), perceived number of users (PNOU) and technology utility (TU) scales were developed by the authors for this research. All responses were measured along a Likert-type scale, with 1 = "strongly disagree," 4 = "neutral," and 7 = "strongly agree."

Perceived Usefulness (PU)

Using an IMS helps me to connect with others instantaneously.
Using an IMS increases my personal productivity.
Using an IMS enhances my personal effectiveness.
I find my IMS to be useful in my life.

Perceived Ease of Use (PEOU)

My interaction with an IMS is clear and understandable.
Interacting with an IMS does not require a lot of mental effort.
I find IMS easy to use.
I find it easy to get an IMS to do what I want it to do.

Behavioral intention to Use (BI)

If I have to use temporarily a computer without IMS software, I intend to download and install it.
If I own a computer with IMS software, I intend to use it.
Given that I have a computer with IMS, I predict that I will use it.
If I had to reinstall all of my software on my computer, I would download and reinstall IMS software.

Actual usage behavior (AB)

I use IMS frequently.
I usually use IMS when I use my computer.

Perceived number of users (PNOU)

From my observations, the number of IMS users is large.
Many of my friends and/or relatives frequently use IMS.
In my opinion, many internet users frequently use IMS.

Technology utility (TU)

From a technical viewpoint, IMS is a useful technology.
From a technical viewpoint, IMS is a wonderful innovation.
From a technical viewpoint, IMS is a valuable messaging service.