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Extending the technology acceptance model to mobile telecommunication innovation: The existence of network externalities

Chih-Chien Wang[1*,†], Shao-Kang Lo[2] and Wenchang Fang[3]
[1]*Graduate Institute of Information Management, National Taipei University, Taiwan*
[2]*Department of International Trade, Chinese Culture University, Taiwan*
[3]*Department of Business Administration, National Taipei University, Taiwan*

- *Consumer acceptance of technological innovations is crucial to marketing new products. According to the most influential model in this area, the Technology Acceptance Model (TAM), perceived usefulness (PU) and perceived ease of use (PEOU) determine users' behavioural intentions to use or purchase a system or product. In the specific context of network externalities, a sense of utility that arises from the number of users (NOU) is considered as important as technology-specific valuation. This study conducted an empirical survey to examine the effects of TAM and network externalities on the acceptance of Multimedia Messaging Services (MMS), an innovation in the field of mobile telecommunications. The results confirm the effectiveness of the TAM and find that network externalities effect affects users' acceptance to this mobile innovations. Accordingly, the TAM can be applied to predict consumer's acceptance to the mobile telecommunication innovations in the presence of network externalities.*

Introduction

There is no guarantee that technology advancements will translate into successful innovation adoption. Consumers' acceptance and intentions to adopt the new technology are crucial aspects of new product marketing. In most cases, the successful diffusion of new technology is partially determined by whether potential users adopt the innovation. Previous studies have presented several models of successful innovation adoption (Roger, 1983; Davis, 1986; Ram and Sheth, 1989). One of the most influential models is the Technology Acceptance Model (TAM) developed by Davis (1986). According to TAM, individual perceptions regarding a new technology could be used to predict acceptance. Davis hypothesised that users' behavioural intentions to use a system are determined by beliefs about two factors – perceived usefulness (PU) and

*Correspondence to: Chih-Chien Wang, Graduate Institute of Information Management, National Taipei University, P.O. Box 4-1, Sansia Township, Taipei County 23799, Taiwan.
E-mail: wangson@mail.ntpu.edu.tw
†Associate Professor.

perceived ease of use (PEOU) (Davis, 1986, 1989).

Mobile phones and other mobile communication products are popular all over the world, and Telecom system providers and mobile phone manufacturers are constantly developing and promoting new applications. However, consumers have not accepted all innovative mobile telecommunications products and services. For instance, the 'Iridium' low earth orbit satellite (LEOS) mobile telecommunication system was apparently an unsuccessful new service that received little user acceptance (Finkelstein and Sanford, 2000). Iridium incorporated some novel technologies and was a feasible solution for mobile communication. It provides a wider coverage even at the sea and mountaintop. Nevertheless, the bulky handset, high cost of communication and other inconveniences discouraged consumers to accept this system. The advanced technology did not ensure its success.

Network externalities provide another perspective on the adoption of technology. This approach is based on the assumption that the perceived benefit often depends on the number of other consumers who purchase identical or compatible items (Katz and Shapiro, 1986). The network externality phenomenon is especially observable in the communications sector. Many, if not all, telecommunications products and service exhibit network externality, in that the benefit to a subscriber depends upon how many communication partners have also subscribed to the service (Rohlfs, 1974; Oren and Smith, 1981; Katz and Shapiro, 1986; Kauffman *et al.*, 2000).

Both TAM and network externalities are well-verified concepts and powerfully explain the acceptance of new technologies. This study addresses the adoption of new mobile telecommunication technologies by combining these two concepts, TAM and network externalities. This study will (a) analyse the role of network externality in the acceptance of mobile telecommunication innovations, and (b) integrate TAM with the network externality concept to develop an extended TAM for mobile telecommunications.

Literature review

Technology acceptance model

TAM was introduced by Davis (1986) to explain technology adoption. The original idea behind this model was first applied in Fishbein and Ajzen's (1975) Theory of Reasoned Action (TRA). According to TRA, a person's manifestation of a specific behaviour is governed by his or her behavioural intention to perform that behaviour; behavioural intention is determined by attitude, and attitude is influenced by beliefs (Fishbein and Ajzen, 1975). Davis applied this sequential conceptualisation and extended the original TRA theory. He included two constructs to establish the TAM. One of the constructs is PU and the other is PEOU.

Davis (1986) suggested that behavioural intention determines the use of technology. Yet, behavioural intention is determined by a person's attitude towards the use of the technology. The attitude is jointly determined by PU and PEOU. PU is influenced by PEOU and external variables such as user characteristics, political influences and others. Davis (1986) defined the PU as the prospective user's subjective probability that using a specific information system will increase his or her job performance. The PEOU is defined as the degree to which the perspective user expects the use of the target system to be free of effort.

Davis *et al.* (1989) modified the original TAM that attitude does not significantly mediate beliefs–intention relationships. They also argued that a user's experience may influence the accuracy of the TAM model and proposed two versions of TAM, one for pre-implementation stage and the other for post-implementation. The pre-implementation TAM predicts technology acceptance according to perceptions of usefulness and ease of use prior to actual implementation or launching. In the post-implementation TAM, PU affects the behavioural intention while easy of use does not.

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Venkatesh and Davis (1996, 2000) also observed that both PU and PEOU directly affect behavioural intentions. They omitted the attitude and called this modified model the extended TAM model. According to the two empirical studies conducted by Venkatesh and Davis, the pre- and post-implementation models should be combined into a single model, based on the findings of longitudinal studies that no significant difference exists between pre- and post-implementation stages.

Empirical studies of the TAM

Davis and his colleagues developed the TAM model to explain and predict the acceptance of information technology (Davis, 1986, 1989; Davis *et al.*, 1989; Venkatesh and Davis, 1996, 2000). Although the TAM was originally proposed for information technology, it is useful in explaining the adoption of other technologies. Several studies have applied this model to various information services, technological products and others innovations. For example, Benamati and Rajkumar (2002) utilised the TAM to explain outsourcing decision of information system. Schaik *et al.* (2002) also examined the PU and ease of use can predict the acceptance of new physiotherapy equipment. Besides, Pavlou (2003) and Wang *et al.* (2005) used the TAM to evaluate the consumer adoption of Internet application.

However, the TAM does not fully reflect the variety of user task environments (Moon and Kim, 2001). Davis himself also argued that future technology acceptance research needs to address how other variables affect usefulness, ease of use and user acceptance (Davis, 1986, 1989). Previous researches have extended the TAM such as Moon and Kim (2001) added the perceived playfulness and Seyal *et al.* (2002) introduced the computer experience as factors affect the Internet use. Cheong and Park (2005) identified that the negative role of perceived price level in developing the intention of mobile Internet usage. Wua and Wang (2002) argued that the perceived risk and compatibility are the variables that affect M-commerce use. Luarn and Lin (2005) proposed that perceived credibility, perceived self-efficacy and perceived financial cost are the extra determinants which influence consumer adoption of mobile banking service.

Network externalities

For some products or services, benefits to consumers depend on the number of other consumers who have purchased compatible devices (Katz and Shapiro, 1986). This phenomenon is called network externality, and is considered in economic approached to the acceptance and diffusion of products and services.

When a product is characterised by network externalities, the number of users (NOU), or the installed base, of the product significantly determines consumer acceptance. The value of the network externalities generated as a by-product of an existing installed base may lead to a 'bandwagon effect' (Farrell and Saloner, 1986; Kauffman *et al.*, 2000), which caused VHS to beat the beta system out of the market (Katz and Shapiro, 1986). A technology with a smaller installed base is more likely to experience technological lockout (Schilling, 2002), which in fact is one reason for the elimination of the beta VCR system (Katz and Shapiro, 1986).

Products with network externalities exhibit different characteristics from products without network externalities effect. Users must consider the core benefit of the technology innovation before they adopt it. Yet, the acceptance of a technology in the presence of network externalities determined by not only the specific value of the technology, but also the network-related value (Farrell and Saloner, 1986). The entire value of the adoption network goods is divided into two parts. The first part is the independent benefit derived from the technology itself. Kauffman *et al.* (2000) call this value the 'stand-alone benefit' or the 'technology-specific valuation (TSV)'. The second type of value is the benefit

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derived from network externality effect. Consumers who use a product with network externalities enjoy added value from other users who use compatible products. Kauffman *et al.* (2000) refer to this value as a 'compatibility benefit' or 'network-related valuation'. Kauffman *et al.* (2000) also presented the entire 'network technology valuation' as TSV plus network-related valuation.

Many products are associated with network externalities and have been examined accordingly. Famous examples include the ATM used in the banking industry (Hannan and McDowell, 1984; Saloner and Shepard, 1995; Kauffman *et al.*, 2000), electronic bill and payment systems (Au and Kauffman, 2001), spreadsheet software packages (Gandal, 1994; Brynjolfsson and Kemerer, 1996) and information systems (Chismar and Meier, 1992; Clemons and Kleindorfer, 1992; Conner, 1995). Among all products with network externalities, the first recognised examples were in the context of telecommunications networks. The value of a network to a subscriber increases with the number of adopters (Artle and Averous, 1973; Rohlfs, 1974; Oren and Smith, 1981; Kauffman *et al.*, 2000). Therefore, the network becomes more attractive to nonsubscribers as the network grows.

Extended TAM

Both the TAM and network externalities refer to the adoption of new technology. This study extended the TAM by incorporating network externalities.

Original TAM addresses the acceptance of new technology in terms of two major constructs – PU and PEOU. These two constructs influence the intention to use (ITU) the technology.

As aforementioned, the mobile telecommunication innovations exhibit the network externalities phenomenon. Before technologies with network externalities are used, consumers consider the value derived from the network as well as the stand-alone value of the products. Actually, the concept of Network Technology Valuation, Kauffman *et al.* (2000) proposed in economic approaches, is consistent with the PU construct. Thus, these two concepts can be synthesised by considering PU as comprising technology-specific valuation and network-related value. A review of the literature reveals that network externality is determined by two approaches – the number of other users who use compatible products and the number of complementary goods. Yet, network effects derived from complementary products are not always present in relation to telecommunications technology. For telecommunication innovation with few complementary goods, the network-related value of telecommunications innovation is only determined by the number of subscribers. **Figure 1** presents the extended model.

This extended model follows the studies conducted by Venkatesh and Davis (1996, 2000) and adds constructs related to network externalities. The actual usage behaviour of adopting a new mobile telecommunication technology is determined by consumer's ITU. The intention of using this technology is affected by PU and PEOU, at the same time, PEOU also indirectly influences the ITU it, mediated by PU. Besides, the technology-specific value and the network-related value are added to the original TAM and are hypothesised positively to affect PU. This extended

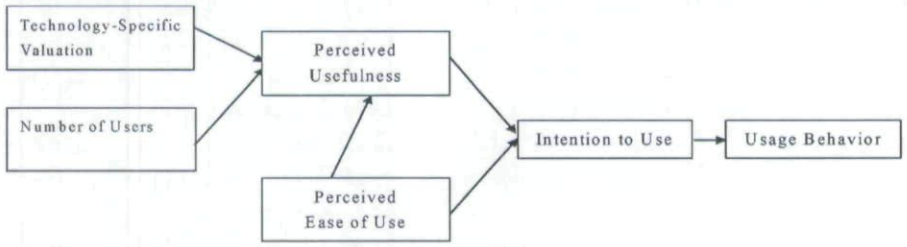

Figure 1. Acceptance of technology with network externalities.

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TAM can be used to evaluate the acceptance of mobile telecommunication innovations and other new technologies with network externalities.

In this study, we propose an extended TAM for mobile telecommunication innovation to predict the consumer's adoption behaviour. However, this study did not examine the relation between 'ITU' and 'usage behaviour' for three reasons. First, these two variables are in a sequential reaction, which needs longitudinal study to confirm it. This empirical study is a cross-section one which collected the data from single time survey. Second, the Multimedia Messaging Services (MMS) is a newest technology and few consumers have experience with using it when this study was conducted. It is hard to collect the actual usage behaviour. Finally, the relation between 'ITU' and 'usage behaviour' is repetitively examined from previous research of psychology, consumer behaviour or other discipline without exception (Ajzen, 1991). It is not always necessary to discuss the relation between these variables for all studies. According to the reasons, present study decided to directly test the relations between antecedents and ITU. We omitted the usage behaviour but the result also predicts this variable by previous literatures.

Multimedia Messaging Service

This study examines the acceptance of MMS. The MMS allows mobile phone users to send multimedia messages such as pictures, audio, video messages. It is a new mobile telecommunication technology, which had been on the market for just few months when this empirical study was conducted. Both the sender and receiver must own a MMS mobile phone for editing and viewing multimedia messages. The MMS is a typical technology with network externalities. The consumers consider the number of MMS mobile phone users as well as the benefits of the technology itself, when making a decision about to adopt MMS. If only a few of a potential user's friends or family members have multimedia mobile phones, then he or she will not be able to gain much value from being able to transfer or receive multimedia messages.

Method

Sample

One thousand three hundred and fifty-two members of three professional societies in Taiwan were selected as subjects. Each subject received a paper-and-pencil questionnaire by mail, asking him or her to rate the perceived stand-alone value, the number of other users, the PU and the ease of use of MMS; he or she was also asked to rate his or her ITU of the service. Responses were obtained from 174 subjects, representing a response rate of 12.87 per cent. Of the 174 responses, nine were discarded owing to missing data, leaving 165 respondents in the final sample. The subjects were aged between 20 and 75 with an average age of 39.32 years old (standard deviation 11.23). One hundred and twenty-six were male and 39 were female.

Researchers have recommended that for Structure Equation Model (SEM) analysis, a sample size from 100 to 200 is appropriate (Boomsma, 1982; Bollen, 1989). The sample size in this study was 165, so SEM analysis could be applied.

Measurement

The measurement scales of PU, PEOU and ITU adapted from Venkatesh and Davis (2000) are used. For the network-related valuation, three-item scale was developed and used to evaluate the NOU. A three-item scale was developed to measure the TSV. All the measurement scales used in this study are 7-point Likert-type scale, where 7 meant strongly agree and 1 meant strongly disagree. The **Appendix** details the questionnaire.

Results

Reliability of scales and demographics of subjects

All scales in this study were highly reliable. The four-item PEOU scale had a Cronbach α

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Table 1. Reliability of scales

	Scales adapted from	Cronbach α of original study	Cronbach α of this study	Means	SD
PU	Venkatesh and Davis (2000)	Range from 0.87 to 0.98	0.954	4.39	1.42
PEOU	Venkatesh and Davis (2000)	Range from 0.86 to 0.98	0.928	4.52	1.23
NOU	This study		0.876	2.94	1.33
TSV	This study		0.829	5.58	1.08
ITU	Venkatesh and Davis (2000)	Range from 0.82 to 0.97	0.906	4.91	1.53

reliability of 0.928. The four-item PU scale had a reliability of 0.954, and the two-item ITU scale had a Cronbach α coefficient of 0.906. For the network technology evaluation, the Cronbach α reliability of the three-item NOU scale was 0.876, and that of the TSV three-item scale was 0.829. All of αs exceeded 0.80, and so the scales were acceptably reliable (Peterson, 1994) (**Table 1**).

In **Table 2**, we present an overview of the correlations between the main variables: TSV, NOU, PEOU, PU and ITU. Result shows all variables with positive and significant relationships.

Among the subjects, 35 owned or had owned a MMS mobile phone, and 130 had not. Thirty-eight of the 165 subjects had used MMS, and 127 had not (**Table 3**).

TAM

The model in this study was analysed and tested by SEM. First, the original TAM model for mobile telecommunication innovation was examined to test the goodness of fit and the relationships among constructs. Some indicators were used to evaluate the adequacy of the model: Goodness-of-Fit Index (GFI), Normed Fit Index (NFI), Non-Normed Fit Index (NNFI) and Adjusted Goodness-of-Fit Index (AGFI). Generally, GFI, NFI and NNFI close to 0.90 and AGFI greater than 0.8 are strong evidence that the overall model being tested fits the data very well (Hair *et al.*, 1992).

The original TAM model has a GFI of 0.93, an NFI of 0.962 and an NNFI of 0.973. Its AGFI is 0.88. Overall, this model fits well. **Figure 2** summarises the results of the SEM analysis. The model shows that PU and PEOU determined ITU, and the PEOU indirectly affects the ITU via the PU. All paths in the model were significant at $p < 0.05$.

Network externalities

Several studies have addressed the network externalities. However, only a few have empirically addressed this phenomenon. This study adopts the perspective of the Kauffman *et al.* (2000) - that the value of products with network externalities must be simultaneously considered on two dimensions - technology-specific value and network-related value. SEM was used to test the model. The GFI, NFI and

Table 2. Pearson correlations between variables

	TSV	NOU	PEOU	PU	ITU
TSV	1	0.183*	0.199*	0.410**	0.372**
NOU		1	0.342**	0.289**	0.249**
PEOU			1	0.443**	0.439**
PU				1	0.641**
ITU					1

*Two-tailed significance < 0.05.
**Two-tailed significance < 0.01.

Table 3. Descriptive statistics

		All
I have ever owned a mobile phone with the Multimedia Messaging Service function	Yes	35 (21.2%)
	No	130 (78.8)
I have ever used the Multimedia Messaging Service function before	Yes	38 (23.0%)
	No	127 (77.0%)

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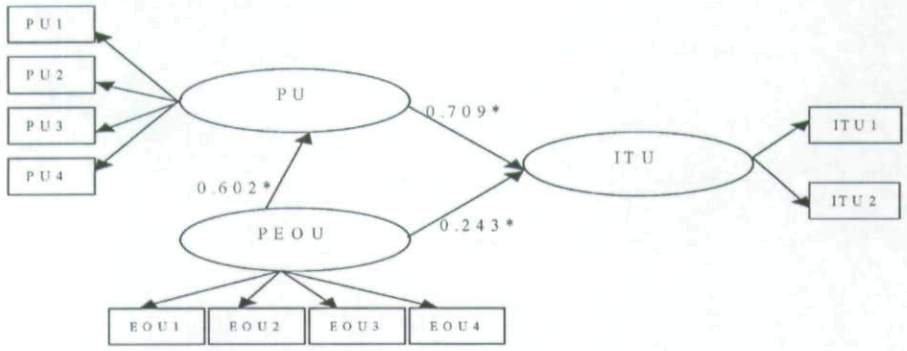

Figure 2. Relationships among constructs of the original TAM.

NNFI of this model are 0.902, 0.931 and 0.939, respectively. The AGFI is 0.837. All these indices exceeded acceptable or marginally acceptable levels. All paths in the model as **Figure 3** showed were significant at $p < 0.05$.

TAM in the presence of network externalities

The extended TAM for mobile telecommunication innovation was examined. This extended model has the GFI of 0.869 and AGFI of 0.820. The NFI and NNFI are 0.912 and 0.943, respectively. NFI and NNFI exceed 0.9 and GFI and AGFI exceed 0.8 so the fit was good or acceptable.

The extended model included TAM and network externality-related concepts. All the paths we postulated above were examined by SEM analysis. All paths were significant at $p < 0.05$. As indicated in **Figure 4**, both TSV and NOU positively influence PU and indirectly affect the ITU via the PU, implying that TAM and network externality are successfully integrated in the extended model. In this new model, PU and PEOU are also shown to determine the ITU directly, and the PEOU indirectly determines ITU through PU. That is, the concept of the original TAM is completely incorporated in this new model.

Discussion

This study empirically examined the TAM and network externality concepts. The results indicate that the original TAM and its measuring scales are valid and reliable. Besides, the results of the empirical survey provided evidence of the relevance of network externalities to mobile telecommunication products. Combining network externality and the TAM yielded an extended TAM for mobile telecommunication innovation. The results of the empirical survey supported the accuracy of this extended model.

According to this extended model, consumers consider PEOU and PU of a technological telecommunication innovation before adopting

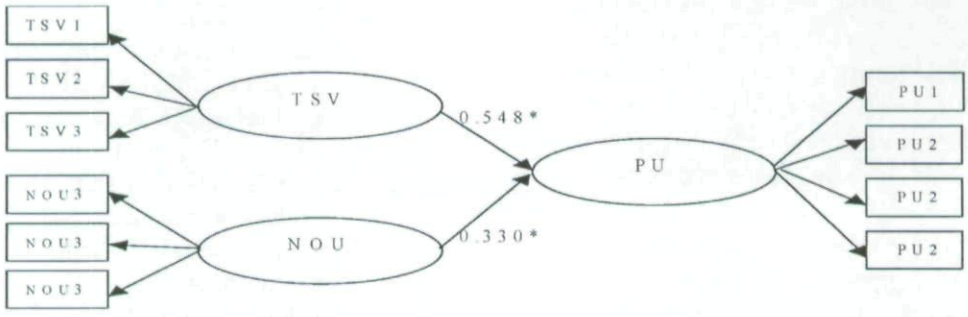

Figure 3. Relationships among constructs of Network Technology Valuation Model.

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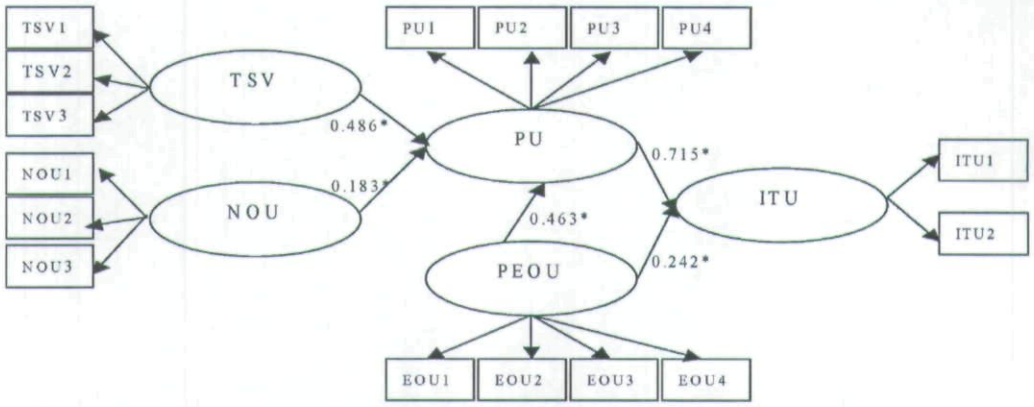

Figure 4. Relationships among constructs of the Extended Technology Acceptance Model.

it. In evaluating the usefulness of the innovation, consumers consider technology-specific value and network externality value. These two values determine PU.

The MMS is one technology innovation. The success of MMS is determined by whether users adopt this innovation. As mentioned above, users evaluate the PU and PEOU in establishing a behavioural intention, and in accepting technology. The MMS is a telecommunication innovation with network externality, so its users will simultaneously consider the technology-specific valuation and the number of other users in evaluating the usefulness of this innovation.

This extended TAM model might be helpful for mobile telecommunication service providers and mobile phone manufactures in identifying the key factors that govern the acceptance of MMS and other telecommunication innovations. Firms should consider how to simplify the operation of new applications and increase the value provided to consumers. Telecommunication service providers should also design properly marketing strategies that increase the number of subscribers rapidly at first so that potential consumers believe that the new technology will become established as the standard in the near future. The NOU, who have purchased compatible items, is one source of value of a technology with network externality. It provides the interconnect ability of networks and influences the acceptance of the technology.

Biographical notes

Chih-Chien Wang, PhD, is an Associate Professor of Information Management at National Taipei University. His research interests include online consumer behaviour and the impact of Internet to society.

Shao-Kang Lo, PhD, is an Assistant Professor in the Department of International Trade, Chinese Culture University, Taiwan. His research interests include online consumer behaviour, electronic commerce and the mobile telecommunications industry.

Wenchang Fang, PhD, is Dean of Business College and Professor of Information Management at National Taipei University. He received his PhD degree from Northwestern University, USA. His research focuses are mainly on electronic commerce and network externalities.

References

Ajzen I. 1991. The theory of planned behavior. *Organization Behavior and Human Decision Processes* **50**: 179–211.

Artle R, Averous C. 1973. The telephone system as a public good: static and dynamic aspects. *Bell Journal of Economics and Management Science* **4**(1): 89–100.

Au YA, Kauffman RJ. 2001. Should we wait? Network externalities, compatibility, and electronic billing adoption. *Journal of Management Information Systems* **18**(2): 47–63.

Benamati J, Rajkumar TM. 2002. The application development outsourcing decision: an appli-

DOI: 10.1002/cb

cation of the Technology Acceptance Model. *Journal of Computer Information Systems* **42**(4): 35–44.

Bollen KA. 1989. *Structural Equations With Latent Variables*. Wiley-Interscience: New York.

Boomsma A. 1982. The robustness of LISREL against small sample sizes in Factor Analysis Model. In *Systems under indirect observation causality structure*, Joreskog KG, Wold H (eds). North-Holland: Amsterdam.

Brynjolfsson E, Kemerer CF. 1996. Network externalities in microcomputer software: an econometric analysis of the spreadsheet market. *Management Science* **42**(12): 1627–1647.

Cheong JH, Park MC. 2005. Mobile internet acceptance in Korea. *Internet Research* **15**(2): 125–140.

Chismar WG, Meier J. 1992. A model of competing interorganizational systems and its application to airline reservation systems. *Decision Support Systems* **8**: 447–458.

Clemons EK, Kleindorfer PR. 1992. An economic analysis of interorganizational Information Technology. *Decision Support Systems* **8**: 431–446.

Conner KR. 1995. Obtaining strategic advantage from being imitated: when can encouraging clones pay? *Management Science* **41**(2): 209–225.

Davis FD. 1986. A Technology Acceptance Model for empirically testing new end-user information systems theory and result. Doctoral Dissertation, Massachusetts Institute of Technology.

Davis FD. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly* **13**(13): 319–339.

Davis FD, Bagozzi RP, Warshaw PR. 1989. User acceptance of consumer technology: a comparison of two theoretical models. *Management Science* **35**(8): 982–1003.

Farrell J, Saloner G. 1986. Installed base and compatibility: innovation, product preannouncements, and predation. *American Economic Review* **76**(5): 940–955.

Finkelstein S, Sanford SH. 2000. The rise and fall of Iridium. *Organizational Dynamics* **29**(2): 138–149.

Fishbein M, Ajzen I. 1975. *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*. Addison-Wesley: Massachusetts.

Gandal N. 1994. Hedonic price indexes for spreadsheets and an empirical test for network externalities. *Rand Journal of Economics* **25**(1): 160–170.

Hair JT, Anderson RE, Tatham RL, Black WC. 1992. *Multivariate data analysis with readings* (3rd edn). Macmillan: New York.

Hannan T, McDowell J. 1984. The determinants of technology adoption: the case of the banking firm. *Rand Journal of Economics* **15**(3): 328–335.

Katz ML, Shapiro C. 1986. Technology adoption in the presence of network externalities. *Journal of Political Economy* **94**(4): 822–841.

Kauffman RJ, McAndrews J, Wang YM. 2000. Opening the 'black box' of network externalities in network adoption. *Information Systems Research* **11**(1): 61–82.

Luarn P, Lin HH. 2005. Toward an understanding of the behavioral intention to use mobile banking. *Computers in Human Behavior*. **21**(6): 873–891.

Moon JW, Kim YG. 2001. Extending the TAM for a World-Wide-Web context. *Information & Management* **38**: 217–230.

Oren SS, Smith SA. 1981. Critical mass and tariff structure in electronic communications markets. *Bell Journal of Economics and Management* **12**(2): 467–488.

Pavlou PA. 2003. Consumer acceptance of electronic commerce: integrating trust and risk with the Technology Acceptance Model. *International Journal of Electronic Commerce* **7**(3): 101–135.

Peterson RA. 1994. A meta-analysis of Cronbach's coefficient alpha. *Journal of Consumer Research* **21**: 381–391.

Ram S, Sheth JN. 1989. Consumer resistance to innovations: the marketing problem and its solutions. *Journal of Consumer Marketing* **6**(2): 5–14.

Roger EM. 1983. *Diffusion of Innovations* (3rd edn). Free Press: New York.

Rohlfs J. 1974. A theory of interdependent demand for a communication service. *Bell Journal of Economics and Management* **5**(1): 16–37.

Saloner G, Shepard A. 1995. Adoption of technologies with network effects: an empirical examination of the adoption of automated teller

DOI: 10.1002/cb

machines. *Rand Journal of Economics* **26**(3): 479–501.

Schaik PV, Bettany-Saltikov JA, Warren JG. 2002. Clinical acceptance of a low-cost portable system for postural assessment. *Behavior and Information Technology* **21**(1): 47–58.

Schilling MA. 2002. Technology success and failure in winner-take-all markets: the impact of learning orientation, timing, and network externalities. *Academy of Management Journal* **45**(2): 387–398.

Seyal AH, Rahman MNA, Rahim MM. 2002. Determinants of academic use of the Internet: a structural equation model. *Behaviour & Information Technology* **21**(1): 71–86.

Venkatesh V, Davis FD. 1996. A model of the antecedents of perceived ease of use: development and test. *Decision Science* **27**(3): 451–481.

Venkatesh V, Davis FD. 2000. A theoretical extension of the Technology Acceptance Model: four longitudinal field studies. *Management Science* **46**(2): 186–204.

Wang CC, Hsu YH, Fang W. 2005. Acceptance to technology with network externalities: an empirical study of internet instant messaging services. *Journal of Information Technology Theory and Application* **6**(4): 15–28.

Wua JH, Wang SC. 2002. An empirical study of consumers adopting mobile commerce in Taiwan: analyzed by structural equation modeling. *Proceedings of the 7th Pacific Asia Conference on Information Systems*, Australia; 81–94.

Appendix. Measurement scales

The scales on which PU, PEOU and ITU are measured were modified from Venkatesh and Davis (2000, p. 201). The scales for measuring the NOU and the TSV developed herein are as follows. They are all 7-point Likert-type scales.

Variable/item	Description
Number of users (NOU)	
NOU1	In my opinion, the number of users of the Multimedia Messaging Service of mobile phone is large
NOU2	Many of my friends and relations frequently use the Multimedia Messaging Service on the mobile phones
NOU3	Many mobile phone users frequently send multimedia messages
Technology-specific value (TSV)	
TSV1	MMS is a useful technology
TSV2	MMS is a technologically wonderful innovation
TSV3	The MMS is a valuable service for communication

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