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Towards an understanding of the behavioral intention to use 3G mobile value-added services

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ABSTRACT

As profit margins gradually decline, and market competition becomes increasingly intensive, 3G telecom operators must provide various mobile value-added services, as well as traditional voice services, to attract new subscribers and retain old ones. However, for many 3G mobile value-added services, whether ARPU (average revenue per user) can be effectively enhanced depends on the consumer behavioral intentions. Therefore, this study uses the Technology Acceptance Model as the foundation and incorporate personal innovativeness and perceived cost to further understand consumer's behavioral intention to use 3G mobile value-added services. The following conclusions can be reached from the research findings: (1) consumer usage rate of current 3G value-added services remains low; (2) increased personal innovativeness will directly enhance the perceived ease of use of 3G mobile value-added services; (3) the perceived usefulness is enhanced when consumers perceive higher ease of use of value-added services; (4) perceived usefulness has the strongest effect on consumer attitude, followed by perceived ease of use and perceived cost, and (5) the most important factor in increasing consumer's behavioral intention to use 3G mobile value-added services is attitude, followed by perceived ease of use, perceived cost and perceived usefulness. Results of this study provide a valuable reference for service providers to develop mobile value-added services.

1. Introduction

Third-generation (3G) mobile communication technology has increased bandwidth, reinforced speed and efficiency of data transmission, as well as increased the speed and convenience of data retrieval. Thus, the invention of the 3G wireless communication system undoubtedly provides a higher wireless bandwidth and more diversified video and audio services to consumers than previously. However, the growing number of mobile telecom users and the decline in conventional voice service tariffs have gradually reduced ARPU (average revenue per user), thus decreasing telecom service provider profits. This situation reveals that revenue from conventional voice services would not be enough for telecom service providers to survive the highly competitive market in the future. Therefore, besides conventional voice services, mobile value-added services have naturally become a new opportunity for providers to create revenue. Telecom service providers have released diverse and abundant mobile value-added services to attract new subscribers, and retain old ones. These 3G value-added services include mobile internet access, mobile intranet/extranet access, customized infotainment, multimedia message service (MMS), location-based service, simple voice service and rich voice service (UMTS, 2000) to meet the various needs of consumers. Although various mobile value-added services have been released, whether ARPU can be effectively enhanced remains a question. Understanding consumer's behavioral intention to use these services has become a key issue.

Behavioral intention is an individual's subjective probability of performing a specified behavior, and is the major determinant of actual usage behavior (Ajzen, 1985; Ajzen & Fishbein, 1980; Yi, Jackson, Park, & Probst, 2006). ARPU could be substantially elevated when consumers are willing to use 3G mobile value-added services and utilize them. Thus, consumer's behavioral intention to use 3G mobile value-added services must be probed. Additionally, investigation into the behavioral intention to adopt information technology (IT) has always been an important issue in information management (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Heijden, Verhagen, & Creemers, 2003; Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Liao, Shao, Wang, & Chen, 1999; Lin & Lu, 2000; Luarn & Lin, 2005; Mathieson, 1991; Mykytyn & Harrison, 1993).

Among the many theoretical perspectives advanced to address IT adoption and usage, the Technology Acceptance Model (TAM) proposed by Davis (1989) is widely accepted as a framework for understanding users' IT acceptance processes. Indeed, TAM has proven to be a parsimonious model with high explanatory power of the variance in users' behavioral intention related to IT adoption and usage across a wide variety of contexts (Taylor & Todd, 1995).

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Therefore, this study is based on TAM. Using personal innovativeness as an external variable, the cost construct is also added to examine consumer's perception of 3G mobile value-added services, and their behavioral intention to use these services. The objectives of this study are to understand the factors affecting consumer's behavioral intention to adopt 3G mobile value-added services, and to analyze the relationships among these factors. Results of this study are useful to practitioners in the telecommunications sector for formulating appropriate marketing strategies to increase 3G mobile value-added services in the future.

2. Literature review and hypothesis development

2.1. Technology Acceptance Model

The Technology Acceptance Model (TAM) was first proposed by Davis in 1989 based on the theory of reasonable action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). TAM is intended to provide a conceptual model featuring a theoretic foundation and parsimony, to explain and predict the behavioral intention and practical behaviors of information technology users, based on the acceptance and use of information technology. Based on the suggestions of previous studies, Davis (1989) and Davis et al. (1989) presented two factors that determine user's acceptance or rejection of information technology, namely perceived usefulness and perceived ease of use. Users who perceive higher ease of use of a certain system think the system is easier to use, generating a positive attitude towards the adoption of the system. If the perceived ease of use is low, then user attitudes are negative. Moreover, perceived ease of use can strengthen perceived usefulness, while attitude and perceived usefulness have significantly positive effects on behavioral intention. Similar to the TRA, TAM suggests that antecedents that directly affect perceived usefulness and perceived ease of use, such as user's personal attribute, system feature, and environmental variable, can be covered by an external variable.

TAM has been used to predict users' intention to accept or adopt a variety of technologies and information systems, and has also recently been used to predict internet and mobile commerce (MC) adoption. Lin and Lu (2000) adopted TAM to study website usage, and found that TAM fully mediated usage behavior, even in the internet environment. Moon and Kim (2001) also studied the use of TAM in the WWW context. They introduced the construct "playfulness" to predict attitude. Their findings indicate that TAM-related hypotheses were all supported: perceived ease of use has a stronger effect on attitude than perceived usefulness in the WWW context, and perceived playfulness has a stronger effect on attitude than perceived usefulness. Heijden et al. (2003) explored factors that influence consumer's intentions to purchase online on an electronic commerce (EC) website. In terms of relative contributions, perceived risk and the perceived ease of use directly influenced attitudes toward purchasing online. Yang (2005) adopted TAM to study factors affecting Singaporeans' attitudes toward MC. They found evidence to support TAM, indicating that consumer innovativeness, past adoption behavior, technology cluster adoption, age and sex affected adoption behavior of users in Singapore. Luarn and Lin (2005) extended the applicability of the TAM to the context of mobile banking, by adding one trust-based construct ("perceived credibility") and two resource-based constructs ("perceived self-efficacy" and "perceived financial cost") to the model. Their findings strongly supported the extended TAM in predicting users' intentions to adopt mobile banking. Wu and Wang (2005) presented an extended TAM that integrates Innovation Diffusion Theory (IDT), "perceived risk" and "cost" into the TAM, to study the factors that determine user MC acceptance. Their findings indicated that all variables except perceived ease of use significantly affect users' behavioral intention. Among them, the "compatibility" had the most significant influence. Liao, Tsou, and Huang (2007) presented an extended TAM considering another variable, "perceived enjoyment", into the original TAM to analyze factors influencing subscribers' usage of 3G mobile services in Taiwan. Their research indicated that perceived usefulness, perceived ease of use and perceived enjoyment are positively related to attitude, and perceived enjoyment has the strongest effect, followed by perceived usefulness and perceived ease of use. Both perceived enjoyment and perceived ease of use positively influenced perceived usefulness. They also found that attitude is the most important factor on behavior intention for 3G services, followed by perceived enjoyment, perceived ease of use and perceived usefulness. The direct effect of perceived usefulness on intention is not significant, but its indirect effect through attitude on intention is significant.

Many studies have adopted TAM to explain and predict the adoption of information technology (Adams, Nelson, & Todd, 1992; Bruner & Kumar, 2005; Davis, 1989; Davis et al., 1989; Heijden et al., 2003; Igbaria et al., 1997; Liao et al., 2007; Lin & Lu, 2000; Luarn & Lin, 2005; Mathieson, 1991; Moon & Kim, 2001; Taylor & Todd, 1995; Wu & Wang, 2005; Yang, 2005). In contrast with other models such as theory of Planned Behavior (TPB) (Ajzen, 1985) and TRA, TAM has substantial theoretical and empirical support, and it is well known for its parsimony. The basic TAM explains and predicts user intention and usage by only two main constructs, perceived usefulness and perceived ease of use. Given the extensive validations in the literature, these two factors are easy to understand and implement in practice. TAM is a model of behavioral intention developed for information technology adoption behavior, so its focus is definite. Its general applicability across different technologies and user contexts can provide researchers with practical utility. TAM can be adopted quickly in empirical research to predict user behavior without specifying additional factors for different technologies, and provides an inexpensive way to gather information about user perceptions of a system. The flexibility of TAM makes it suitable for various diverse technologies (Hong, Thong, & Tam, 2006). Hence, TAM is conceived as an extremely appropriate baseline model for this research background and objectives.

In TAM, antecedents that directly influence perceived usefulness and perceived ease of use are generalized by only an external variable. Follow-up researchers may not be able to directly identify the content of the external variable in the TAM (Dishaw & Strong, 1999). Previous studies generally neglected external variables, in comparison with other variables (Igbaria, Guimaraes, & Davis, 1995). Consequently, this study introduces personal innovativeness as an external variable, and also adds the cost construct to further understand consumer's behavioral intention to adopt 3G mobile value-added services.

2.2. Personal innovativeness

Personal innovativeness is also an important factor affecting adoption behavior for new technologies (Agarwal & Prasad, 1998; Hung, Ku, & Chang, 2003; Lin, 1998; Lin & Jeffres, 1998; Yang, 2005). Innovativeness is the willingness to adopt an innovative technology. In other words, it is the degree of interest in trying a new thing, new concept, or an innovative product or service (Rogers, 1995). According to Innovation Diffusion Theory (Rogers, 1995), the adoption of innovative technology is closely related to willingness to try and accept new things. Agarwal and Prasad (1998) noted that personal innovativeness mediates perceptions in the decision to adopt information technology. Consequently, higher personal innovativeness leads to a more positive information technology adoption behavior. Yang (2005) adopted seven per-

sonal attributes, namely personal innovativeness, past adoption behavior, knowledge, technology cluster, age, sex and specialization, as indicators for the external variable of perceived usefulness and perceived ease of use to study the adoption of mobile commerce. Analytical results indicate that "personal innovativeness" has significantly positive effects on perceived usefulness and perceived ease of use. Thus, the following hypotheses can be established:

H1: Personal innovativeness positively influences perceived usefulness of 3G mobile value-added services.
H2: Personal innovativeness positively influences perceived ease of use of 3G mobile value-added services.

2.3. Perceived usefulness, perceived ease of use, attitude, and behavioral intention

Many empirical studies in information management have considered TAM, and have generally supported the hypotheses of TAM, i.e., perceived ease of use can strengthen perceived usefulness (Adams et al., 1992; Davis, 1989; Davis et al., 1989; Heijden et al., 2003; Igbaria et al., 1997; Karahanna & Straub, 1999; Liao et al., 2007; Lin & Lu, 2000; Moon & Kim, 2001; Taylor & Todd, 1995), perceived usefulness and perceived ease of use have significantly positive effects on user attitudes (Davis et al., 1989; Lin & Lu, 2000; Moon & Kim, 2001; Taylor & Todd, 1995); perceived usefulness has significantly positive effects on behavioral intention (Davis et al., 1989; Lin & Lu, 2000; Moon & Kim, 2001; Taylor & Todd, 1995), and attitude also has significantly positive effects on behavioral intention (Davis et al., 1989; Heijden et al., 2003; Lin & Lu, 2000; Moon & Kim, 2001). The studies of mobile commerce based on TAM produced similar findings. For instance, a user who perceives a higher usefulness of mobile commerce has a stronger attitude for adoption (Bruner & Kumar, 2005; Hung et al., 2003; Liao et al., 2007; Yang, 2005). A user who perceives a higher ease of use of mobile commerce also has a stronger attitude for adoption (Hung et al., 2003; Liao et al., 2007). Higher perceived ease of use leads to higher perceived usefulness (Bruner & Kumar, 2005; Liao et al., 2007; Luarn & Lin, 2005; Wu & Wang, 2005). Perceived usefulness positively influences behavioral intention (Luarn & Lin, 2005; Wu & Wang, 2005). Attitude also positively influences behavioral intention (Bruner & Kumar, 2005; Hung et al., 2003; Liao et al., 2007; Teo & Pok, 2003). Thus, the following hypotheses can be established:

H3: Perceived ease of use positively influences perceived usefulness of 3G mobile value-added services.
H4: Perceived usefulness positively influences attitude of 3G mobile value-added services.
H5: Perceived ease of use positively influences attitude of 3G mobile value-added services.
H6: Perceived usefulness positively influences behavioral intention of 3G mobile value-added services.
H7: Attitude positively influences behavioral intention of 3G mobile value-added services.

2.4. Perceived cost

Among the issues related to information technologies, many scholars considered cost as an important factor affecting user's behavioral intention (Hung et al., 2003; Luarn & Lin, 2005; Wu & Wang, 2005). Constantinides (2002) argued that in the process of transferring e-commerce to mobile commerce has various costs, namely equipment cost, access cost and conversion cost. However, these costs may increase usage fee of wireless mobile commerce to the level higher than that of wired e-commerce. Additionally, excessive cost of value-added services affects consumer adoption of value-added services (Erlandson & Ocklind, 1998; Schultz, 2001). In a study of personal adoption of mobile banking, Luarn and Lin (2005) pointed out that perceived financial cost has significantly negative effects on users' behavioral intention. Wu and Wang (2005) also discovered that perceived cost has significantly negative effects on user adoption of mobile commerce. Hung et al. (2003) probed into the relationship between the cost of value-added services and consumer attitudes, and discovered that the cost of value-added services negatively influences consumer attitudes toward the use of WAP services. Thus, the following hypotheses are proposed:

H8: Perceived cost negatively influences the attitude of 3G mobile value-added services.
H9: Perceived cost negatively influences behavioral intention of 3G mobile value-added services.

Fig. 1 shows the proposed model based on the above analysis.

3. Research method

3.1. Questionnaire design

Based on the hypothesized model (Fig. 1) developed through a detailed review of the related literature on user acceptance of technology, personal innovativeness and perceived cost, a 22-item questionnaire was devised as a measurement scale for the research. Since the questionnaire from the literatures was originally developed in English, a university graduate with special training in English–Chinese translation translated it into Chinese. Another trained translator performed a back-translation to ensure that the original translation was accurate. After the draft was designed, a pretest was performed on users and experts familiar with mobile value-added services to modify ambiguous expressions. Based on the respondents' feedback, the questionnaire was adjusted to improve its readability and ensure its accuracy and appropriateness. The questionnaire was then adopted in a pilot test involving 50 undergraduate and graduate students from one university in Taiwan, who completed the questionnaire. An exploratory factor analysis was performed on the data collected from the pilot study. An item was deleted if its corrected item-to-total correlation was below 0.4. Five items were eliminated at this stage. The Cronbach's alpha value for each construct was calculated. The Cronbach's alpha value for each construct ranged from 0.764 to 0.887 surpassing the standard threshold value of 0.70 (Nunnally, 1978), thus revealing good reliability. Participants in the formal survey, thus could clearly understand each question, and the content validity could be assured. The formal questionnaire comprised two parts. The first part was intended to understand subject's basic data and their use of mobile phones and 3G mobile value-added services. All the measurement scales were nominal. The second part measured the subject's perception of each construct in the model. The questionnaire adopted a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Table 1 shows the constructs and questions included in this questionnaire.

3.2. Subjects

Taiwan has a mobile phone penetration rate of 102.97%, with 3G phone users accounting for 24% of all users, and rising fast (FIND, 2007). Therefore, this study focused on Taiwanese consumers as research subjects. Approximately 57.5% of people in Taiwan have adopted mobile value-added services recently,

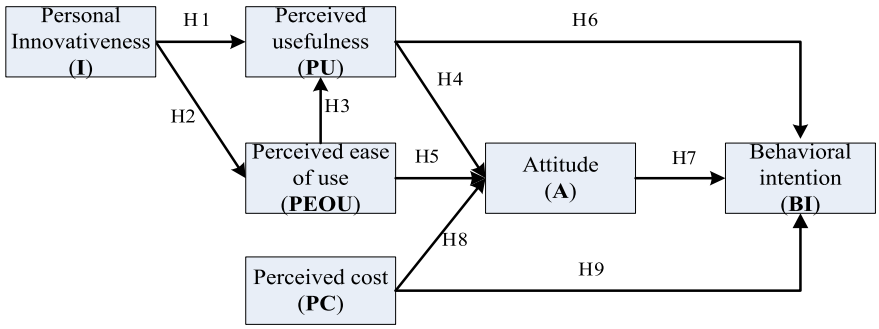

Fig. 1. Research model.

Table 1
Constructs and questions included in the questionnaire

Construct	Item	Measurement	Reference
Personal innovativeness (I)	I1	I am curious about various things.	Hung et al. (2003) and Yang (2005)
	I2	I think it is very interesting to try new things.	
	I3	Generally speaking, I like to accept new things.	
Perceived usefulness (PU)	PU1	Using 3G value-added services can increase the efficiency of my life and work.	Karahanna and Straub (1999), Hung et al. (2003), and Wu and Wang (2005)
	PU2	Using 3G value-added services can help me accomplish tasks in my life and work more easily.	
	PU3	3G value-added services can provide me useful information about my life and work.	
Perceived ease of use (PEOU)	PEOU1	Learning to use 3G value-added services is very simple.	Karahanna and Straub (1999), Teo and Pok (2003), and Wu and Wang (2005)
	PEOU2	It is extremely easy to be familiarized with the use of 3G value-added services.	
Perceived cost (PC)	PC1	I think telecom service providers should reduce the tariff of value-added services.	Hung et al. (2003), Luarn and Lin (2005), and Wu and Wang (2005)
	PC2	For me, the current 3G value-added tariff is still high.	
	PC3	Generally speaking, I cannot accept the current tariff of 3G value-added services.	
Attitude (A)	A1	I think using 3G value-added services is a good idea.	Taylor and Todd (1995), Teo and Pok (2003), and Hung et al. (2003)
	A2	I think using 3G value-added services to help me collect information is a good idea.	
	A3	Generally speaking, I like the idea of 3G value-added services.	
Behavioral intention (BI)	BI1	I plan to use 3G value-added services in the future.	Taylorand Todd (1995), and Karahanna and Straub (1999)
	BI2	If possible, I will try to use 3G value-added services.	
	BI3	I will try to use 3G value-added services if necessary in life or work.	

and most of them (54.2%) are aged 21–30 years old (FIND, 2006). Therefore, if this age group was selected for sampling, the result would be representative to a certain degree of the population. Most users in this age range are studying in college or graduate school, and are distributed across the whole island. Thus, under limited research resources, this study chose five universities in Taiwan to adopt the undergraduates and graduate students as research samples. A total of 350 questionnaires were distributed. Excluding missing and invalid answers included questions answered wrongly (for instance, where the respondent gave more than one answer to a question that expected only one answer), or left blank, 269 valid responses were collected. The valid response rate was 76.86%.

4. Data analysis, results and discussion

4.1. Sample characteristics

Among the 269 valid responses, only 29 subjects were reported to have used 3G value-added services, taking up only 10.8%. As shown in Table 2, 137 respondents were males (50.9%) and 132 were females (49.1%). In terms of educational background, graduate students accounted for 57.2%, and all the other subjects were undergraduates. Among the 29 subjects who had adopted 3G value-added services, most of them adopted services provided by China Telecom (62.1%). In terms of experience of use, 76% of the subjects had used 3G value-added services for no longer than one year. Approximately 93% of the users reported that they used value-added services for no longer than 30 min a month, and 51% used the services for less than 10 min. On average, most of them (58.6%) spent less than NT$100 on value-added services each month, while 24.1% of them spent NT$101–200.

Among the types of 3G value-added services[1] (Table 3), nearly 50% of the subjects had adopted MP3 ring tone download services (48.3%). The other commonly used value-added services were MMS (37.9%), video news (27.6%), photo download (24.1%), mobile JAVA-based games (13.8%) and MV download (13.8%). Among the reasons for not using 3G value-added services[2] (Table 4), the excessive usage fee was the primary factor (78.8%), followed in order by insufficient understanding about the usage (52.4%), incompatibility of their present mobile phone (43.5%), and the current 3G mobile value-added services not being compliant with their personal needs (34.6%).

[1,2]The two questions are multiple-answer questions.

Table 2
Demographic characteristics of the respondents

Demographic profile		Frequency	Percent (%)
All samples			
Gender (n = 269)	Male	137	50.9
	Female	132	49.1
Educational level (n = 269)	College	115	42.8
	Graduate school	154	57.2
Samples have used 3G value-added services			
3G telecom firms (n = 29)	Taiwan Cellular Corp.	5	17.2
	Asia Pacific Telecom	1	3.4
	China Telecom	18	62.1
	VIBO Telecom	2	6.9
	Far Eastone Telecommunications	3	10.3
Experiences in 3G value-added services (year) (n = 29)	Less than 0.5	10	34.4
	0.5–1	12	41.4
	1–2	3	10.3
	2 or above	4	13.8
Average usage time in 3G value-added services per month (n = 29)	Less than 10 minutes	15	51.7
	10–30 min	12	41.4
	30 mins–1 h	1	3.4
	1–2 h	1	3.4
Expenditure in 3G value-added services per month (NT dollar) (n = 29)	Less than 100	17	58.6
	101–200	7	24.1
	201–300	2	6.9
	301–400	0	0
	400 or above	3	10.3

Table 3
Types of 3G value-added services[a]

Types	Frequency	Percent (%) (n = 29)	Rank
MP3 ring tone download service	14	48.3	1
MMS service	11	37.9	2
Video news	8	27.6	3
Photo download	7	24.1	4
Mobile JAVA-based games	4	13.8	5
MV download	4	13.8	5

[a] This question is a multiple-answer question.

Table 4
Factors for not using 3G value-added services[a]

Factors	Frequency	Percent (%) (n = 269)	Rank
Excessive usage fee	212	78.8	1
Insufficient understanding about the usage	141	52.4	2
Incompatibility of the present mobile phone	117	43.5	3
The current 3G mobile value-added services not compliant with personal needs	93	34.6	4

[a] This question is a multiple-answer question.

4.2. Results and discussion

The research model and the proposed hypotheses were evaluated by the structural equation model (SEM). The analysis tool used in this study was LISREL 8.52. Parameter estimation was performed by maximum likelihood estimation.

4.2.1. Measurement model

The measurement model fit was assessed by a confirmatory factor analysis (CFA). Seven common model-fit measures were used to estimate the measurement model fit; chi-square/degree of freedom (χ^2/d.f.), the goodness-of-fit index (GFI), root mean square error of approximation (RMSEA), root mean square residual (RMR), the normed fit index (NFI), non-normed fit index (NNFI), and the comparative fit index (CFI). According to Table 5, all the model-fit indices exceed their respective common acceptance levels suggested in the prior literature (Hair, Anderson, Tatham, & Black, 1998). Therefore, it can be concluded that the measurement model has good fit with the data collected.

In addition to the model fit, the reliability, the convergent validity, and the discriminant validity of the scale were examined. As shown in Tables 6 and 7, all squared multiple correlations (SMC) of the measured variables were higher than the criterion (0.5), and the composite reliability (CR) values of all the constructs were above the recommended level of 0.6, indicating that all measures had good reliability (Bagozzi & Yi, 1988; Hair et al., 1998). Moreover, the completely standardized factor loadings all reached the level of significance, all the constructs had a CR above 0.6, and the average variance extracted (AVE) values for all constructs were higher than the suggested threshold value of 0.50, suggesting the convergent validity of the scale (Fornell & Larcker, 1981). Comparing the square root of the AVE with the correlations among the constructs indicates that each construct is more closely related to its own measures than to those of other constructs, and discriminant validity was therefore supported (Fornell & Larcker 1981). Overall, the evidence of good model fit, reliability, convergent validity, and discriminant validity indicates that the measurement model was appropriate for testing the structural model at a subsequent stage.

Table 5
Fit indices for measurement model

Fit indices	Recommended value	Result
χ^2/d.f.	<3	2.408
GFI (goodness of fit index)	>0.9	0.906
RMSEA (root mean square error of approximation)	<0.08	0.073
RMR (root mean square residual)	<0.08	0.054
NFI (normed fit index)	>0.9	0.940
NNFI (non-normed fit index)	>0.9	0.948
CFI (comparative fit index)	>0.9	0.962

Table 6
Standardized factor loadings, SMC and CR

Construct	Item	Factor loading	SMC	CR
I	I1	0.857[a]	0.734	0.890
	I2	0.923[a]	0.852	
	I3	0.775[a]	0.601	
PU	PU1	0.818[a]	0.669	0.901
	PU2	0.951[a]	0.904	
	PU3	0.829[a]	0.687	
PEOU	PEOU1	0.962[a]	0.925	0.848
	PEOU2	0.749[a]	0.554	
PC	PC1	0.793[a]	0.629	0.902
	PC2	1.000[a]	1.000	
	PC3	0.813[a]	0.661	
A	A1	0.785[a]	0.616	0.858
	A2	0.865[a]	0.748	
	A3	0.787[a]	0.619	
BI	BI1	0.788[a]	0.621	0.872
	BI2	0.995[a]	0.990	
	BI3	0.725[a]	0.526	

$CR = \frac{(\sum \lambda_i)^2}{[(\sum \lambda_i)^2 + \sum(\theta_i)]}$; λ = factor loading; θ = measurement error of each measured variable.

[a] $p < 0.01$.

Table 7
Inter-variable correlations

Construct	I	PU	PEOU	PC	A	BI
I	**0.730**					
PU	0.129	**0.754**				
PEOU	0.218	0.415	**0.739**			
PC	−0.283	−0.021	−0.043	**0.757**		
A	0.226	0.561	0.508	−0.197	**0.670**	
BI	0.209	0.275	0.314	−0.287	0.627	**0.698**

Diagonal elements show the average variance extracted (AVE). Off-diagonal elements show the shared variance. $AVE = \frac{(\sum \lambda^2)}{[(\sum \lambda^2) + \sum(\theta_i)]}$; λ = factor loading; θ = measurement error of each measured variable.

4.2.2. Structural model test

Table 8 shows the common model-fit indices, recommended values and results of the test of structural model fitness. A comparison of all fit indices with their corresponding recommended values (Hair et al., 1998), as shown in Table 8, indicate a good model fit.

Given the satisfactory fit of the model, the estimated path coefficients of the structural model were then studied to evaluate the hypotheses. Fig. 2 shows the standardized path coefficients, t values and coefficients of determination (R^2) of the latent variables. Most of the hypotheses were strongly supported, except for hypothesis H1 ($\gamma = 0.039$; $t = 0.609$) and H6 ($\beta = 0.083$; $t = 1.300$). The research results and discussions are shown as follows:

Table 8
Fit indices for structural model

Fit indices	Recommended value	Result
χ^2/d.f.	<3	2.330
GFI (goodness of fit index)	>0.9	0.905
RMSEA (root mean square error of approximation)	<0.08	0.071
RMR (root mean square residual)	<0.08	0.055
NFI (normed fit index)	>0.9	0.940
NNFI (non-normed fit index)	>0.9	0.951
CFI (comparative fit index)	>0.9	0.963

(1) The effect of personal innovativeness on perceived usefulness and perceived ease of use.Personal innovativeness had no significantly positive effect on perceived usefulness ($\gamma = 0.039$; $t = 0.609$), so H1 was not supported. According to the analytical results, the perceived usefulness of 3G value-added services does not rise even when consumers are willing to try and accept new things. Perceived ease of use was positively influenced by personal innovativeness ($\gamma = 0.222$; $t = 3.368$), so H2 was supported. This result is consistent with the finding of Yang (2005). This study indicates that consumers who are more inclined to try new products or who have a higher demand for new things feel that value-added services are easy to use, and operate in the process of using them.

(2) The effect of perceived ease of use on perceived usefulness.Perceived ease of use had a significantly positive effect on perceived usefulness ($\beta = 0.408$; $t = 5.525$), so H3 was supported. This result is consistent with those of previous studies (Adams et al., 1992; Bruner & Kumar, 2005; Davis et al., 1989; Heijden et al., 2003; Igbaria et al., 1997; Liao et al., 2007; Lin & Lu, 2000; Luarn & Lin, 2005; Moon & Kim, 2001; Taylor & Todd, 1995; Wu & Wang, 2005). It also implies that telecom service providers need to consider the ease of use of services when identifying the 3G value-added services that can offer practical values to consumers. The perceived usefulness of 3G mobile value-added services falls if service providers cannot provide simple and easy-to-operate value-added services.

(3) The effect of perceived usefulness, perceived ease of use and perceived cost on attitude.Perceived usefulness had significantly positive influence on attitude ($\beta = 0.429$; $t = 6.790$), so H4 was supported. Perceived ease of use also had significantly positive effect on attitude ($\beta = 0.324$; $t = 4.740$), so H5 was supported. These results echo those of previous studies

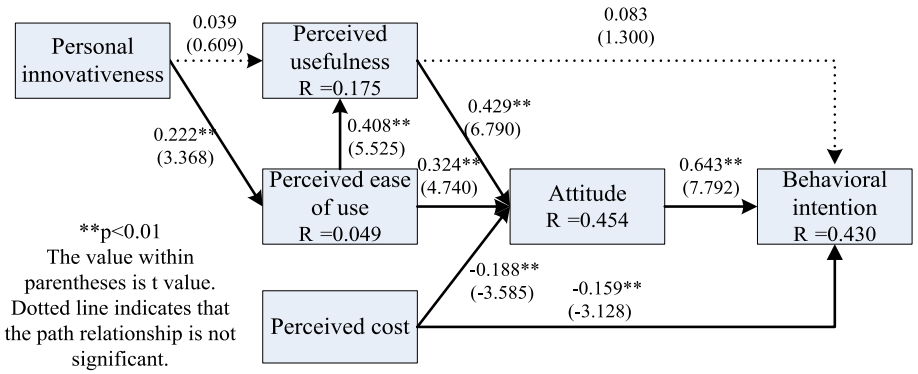

Fig. 2. Results of the model.

(Davis et al., 1989; Liao et al., 2007; Lin & Lu, 2000; Moon & Kim, 2001; Taylor & Todd, 1995). Thus, consumers adopt more positive attitudes toward adoption of services when they perceive higher usefulness and ease of use of 3G value-added services. Perceived cost had a significantly negative effect on attitude ($\gamma = -0.188$; $t = -3.585$), so H8 was supported. Thus, consumers' attitudes become more negative when the perceived cost of 3G mobile value-added services is higher. This result is consistent with those of Hung et al. (2003).

The path coefficients (Fig. 2) indicate that perceived usefulness had the strongest effect on attitude, followed by perceived ease of use and perceived cost. This situation is consistent with the argument in TAM that perceived usefulness is the most decisive factor affecting adoption attitude (Davis, 1989; Davis et al., 1989), and is also consistent with the findings of Liao et al. (2007) within the context of 3G mobile services. The first step for service providers in encouraging consumers to hold positive attitudes toward 3G value-added services is to enhance the usefulness of 3G value-added services, and the second step is to make the services easy to use. The last step is to reduce the perceived cost.

(4) The effect of perceived usefulness, perceived cost and attitude on behavioral intention.Perceived usefulness had no significant effect on behavioral intention ($\beta = 0.083$; $t = 1.300$), so H6 was not supported. This result is not consistent with the hypothesis of TAM, but it echoes the findings of Liao et al. (2007). This inconsistency can probably be attributed to the low usage of 3G value-added services by the research subjects. Additionally, the research subjects were undergraduate and graduate students, and mainly used MP3 ring tone download and MMS among the value services. These services are not useful to their life and work. Perceived cost had a significantly negative effect on behavioral intention ($\gamma = -0.188$; $t = -3.585$), so H9 was supported. This result echoes the findings of Luarn and Lin (2005) and Wu and Wang (2005), and also confirms that the main reason why consumers do not use 3G value-added services is "excessive usage fee" (78.8%). Attitude had a significantly positive effect on behavioral intention ($\beta = 0.643$; $t = 7.792$), so H7 was supported. This result is consistent with the findings of previous studies (Bruner & Kumar, 2005; Davis et al., 1989; Heijden et al., 2003; Liao et al., 2007; Lin & Lu, 2000; Moon & Kim, 2001). Finally, the direct effect, indirect effect, and total effect of each construct on consumer's behavioral intention to use 3G value-added services were calculated (Table 9). According to this study, the total effect of these constructs on behavioral intention is ranked as follows: attitude > perceived ease of use > perceived cost > perceived usefulness > personal innovativeness. These findings are consistent with those of Liao et al. (2007), attitude is the most important factor influencing behavior intention for 3G mobile services, followed by perceived enjoyment, perceived ease of use and perceived usefulness. Perceived ease of use explained the 17.5% variance of perceived usefulness, as indicated in Fig 2. Personal innovativeness explained the 4.9% variance of perceived ease of use. The variance explained was excessively small, meaning that other factors could explain perceived ease of use. Perceived usefulness, perceived ease of use, and perceived cost jointly explained the 45.4% variance of attitude. Attitude and perceived cost jointly explained the 43.0% variance of behavioral intention.

Table 9
The direct, indirect, and total effect of each construct on behavioral intention

Name of Construct	Direct effect	Indirect effect	Total effect
Attitude	0.643	NA	0.643
Perceived ease of use	–	0.321	0.321
Perceived usefulness	–	0.276	0.276
Perceived cost	−0.159	−0.121	−0.280
Personal innovativeness	–	0.071	0.071

5. Conclusions and suggestions

This study investigated consumer's behavioral intention to adopt 3G mobile value-added services. The following major conclusions and suggestions were obtained. First, 3G mobile communication has been available for some time. Although consumers can easily adopt high-speed data transmission through the 3G system, enjoy video/audio entertainment and the convenience of retrieve life information, the usage rate of current 3G value-added services is still low, and stickiness does not occur. Hence, consumers are still unwilling to spend much time and money on these value-added services, and service flow cannot be augmented to create revenue. This conclusion serves as a warning for telecom service providers, who view the young user group as the target market of value-added services. Second, consumers with higher personal innovativeness perceive a higher ease of use of value-added services. Those who feel that the value-added services are easy to operate and use can also perceive a higher usefulness of the services. Among the constructs affecting consumer's attitude, perceived usefulness has the largest effect, followed by perceived ease of use and perceived cost. Finally, to enhance consumer's behavioral intention to adopt 3G value-added services, attitude should be the primary focus, followed by perceived ease of use, perceived cost and perceived usefulness. Most of the current 3G telecom service providers in Taiwan have focused on promoting high-speed transmission, and have not probed into consumer's attitude and other related factors. Hence, consumers have not widely adopted 3G services. To enhance consumer's behavioral intention, providers do not need to convey much technical information to consumers when they promote value-added services, but instead only focus on improving consumer attitudes. The elevation of attitude depends on the rise in perceived usefulness and perceived ease of use, or the reduction of perceived cost. To improve perceived ease of use, providers can adopt the concept of "one-stop shopping" to provide a single and friendly interface for consumers to acquire the desired service content through the simplest experience. To reduce the perceived cost, providers can increase consumer's adoption intention by reducing the tariffs of value-added services. Service providers are recommended to adopt promotions to reduce the threshold of service tariff or service packages to promote 3G value-added services. For instance, specific service combinations (such as video download plus game download) can be adopted to attract consumers interested in a single value-added service. However, if the service tariff cannot be reduced, then service providers should develop more valuable and special services, so that consumers can enjoy the benefits or effectiveness of 3G value-added services at a lower cost, thus significantly reducing the high service tariffs. Clearly, practical services should be continuously provided to consumers in order to improve the perceived usefulness.

The limitations of this study are as follows. (1) The research subjects constituted the main user group of value-added services (undergraduates and graduate students), meaning that the research results could not be used to generalize all consumers. (2) The 3G telecom service market in Taiwan is still under development. Sampling all the practical users of 3G value-added services was not feasible. (3) Due to time constraints, only cross-sectional

data were adopted, and the survey was performed at a specific time point for empirical analysis. Since the longitudinal research method could not be adopted, prudence was required in the discussion of causal relationships between constructs.

Future studies could make an in-depth investigation when consumers have a higher level of involvement in 3G value-added services to acquire more objective arguments. Moreover, this study incorporated personal innovativeness as the antecedent affecting perceived usefulness and perceived ease of use, and used perceived cost to expand the TAM. However, research results indicate that personal innovativeness cannot alone explain perceived usefulness and perceived ease of use. Thus, follow-up studies could examine the external variables affecting the adoption of 3G value-added services, such as content richness and media entertainment. The sampled user group could be enlarged, and the differences in behavioral intention between different user groups could be compared.

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