

Full Length Research Paper

Subscriber behavior in adopting 3G value-added services

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Third generation (3G) mobile services have not performed as much as they were expected to do a decade ago due to limited exemplary handset capacity, overlooking subscriber behavior and so on. This paper examined customers' behavioral intention of adopting 3G value-added services, particularly, the Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB) models. Structural Equation Modeling (SEM) was developed to analyze the data set which included 233 interviews on customer perception of Secured Handset Enabler (SHE) application. Important factors such as perceived usefulness and perceived ease-of-use are incorporated into the models. Some useful findings were presented which will help an Application Service Provider (ASP) to correctly analyze and understand subscribers' intentions and service demand, and the needed strategies to promote their services.

Key words: 3G Services, secured handset enabler (SHE), value-added service, theory of planned behavior (TPB), technology acceptance model (TAM).

INTRODUCTION

The 3rd generation (3G) mobile services which came

after those of the second generation (2G) with great success in winning approximately 3.8 billion subscribers worldwide, are targeted to enrich mobile users' experiences anywhere and anytime by providing voice applications, multimedia entertainment services and seamless mobile broadband data access through the support of pocket personal computer (PC), smartphone, or personal digital assistant (PDA) device. For over a decade of 3G business practice, the number of the subscribers transferring from 2G to 3G has reached 570 million, however, this number only accounts for a relatively small portion of the overall mobile market. The issues faced by 3G include the unsatisfactory 3G user segmentation and the frustrated market, which result in low return on investment (ROI), discouraging related investment decisions. These problems are partially caused by system providers and operators' optimistic view of 3G business operation as well as expensive tariff and overlooked subscriber behavior. Secured handset enabler (SHE) comprises a series of software-controlled remote mechanisms which include remote lock, remote

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Abbreviations: 3G, Third generation; TAM, technology acceptance model; TPB, theory of planned behavior; SEM, structural equation modeling; SHE, secured handset enabler; ASP, application service provider; PC, personal computer; PDA, personal digital assistant; 2G, second generation; ROI, return on investment; BI, behavioral intention; IT, information technology; ATT, attitude towards behavior; SN, subjective norm; PBC, perceived behavioral control; IS, information system; SPSS, statistical package for the social sciences; AGFI, adjusted goodness-of-fit index; CFI, comparative fit index; IFI, incremental fit index; PGFI, parsimony goodness-of-fit index; PCFI, parsimonious comparative fit index; PNFI, parsimonious normed fit index; RMR, root mean square residual; GFI, goodness-of-fit index; NFI, normed fit index; RMSEA, root mean square error of approximation; PEOU, perceived ease-of-use; PU, perceived usefulness; 4G, fourth generation.

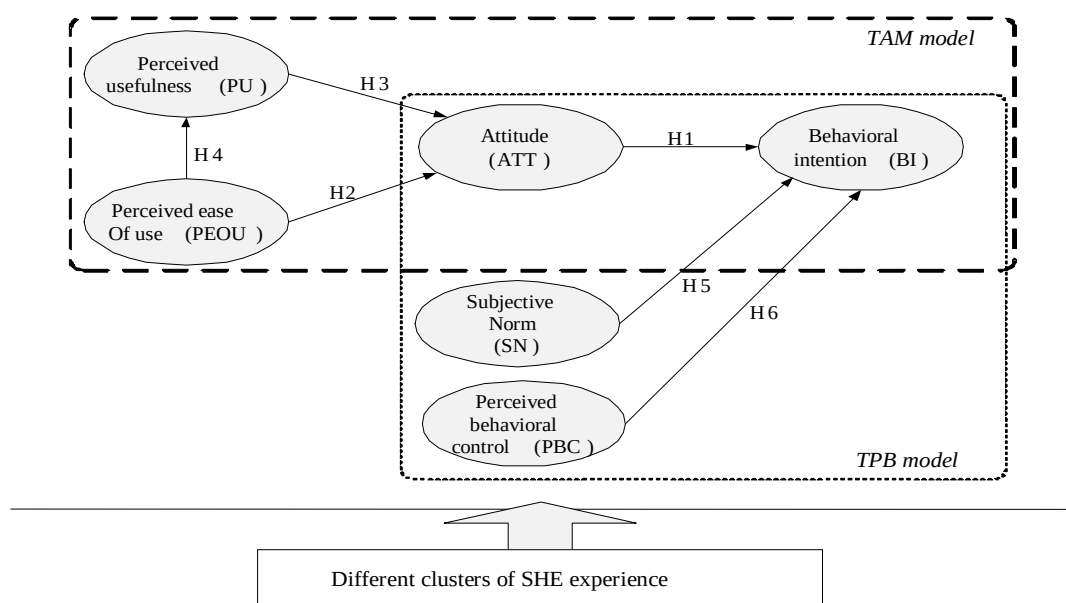


Figure 1. The model.

unlock, remote delete and remote handset protection capabilities that enable subscribers to remotely access the place where sensitive personal data are stored in their mobile device. Understanding subscriber behavioral intention (BI) of adopting 3G value-added services will help an application service provider (ASP) to correctly analyze and understand subscribers' intentions and service demand, and the needed strategies to promote their services. In addition, studying various related parameters will also help us to obtain more useful data to determine 3G market demand and improve 3G business environments. At present, 3G value-added services are being developed as an emerging field; existing research on subscriber behavior of 3G value-added services is scanty (Yan, 2008). Using structural equation modeling (SEM), this paper investigated consumers' willingness to make use of handset security management applications service.

RESEARCH FRAMEWORK AND HYPOTHESIS DEVELOPMENT

The model used in this paper, which is depicted in Figure 1, was based on Davis (1989), Ajzen (1991) Taylor and Todd (1995), and Bhattacharjee (2001), though it was originally developed for the technology acceptance model (TAM) (Qi et al., 2009) and the theory of planned behavior (TPB) (Ajzen, 1991, 2002). TAM considers that a user's BI to initially adopt an innovative information system is jointly determined by his/her attitude towards

using the system and perceived usefulness (PU), whereas attitude is a direct function of PU and perceived ease-of-use (PEOU). TPB can explain and predict an individual's acceptance of information technology (IT). According to TPB, an individual's BI is determined by BI and perceived behavioral control (PBC), and BI is determined by attitude toward behavior (ATT), subjective norm (SN) and PBC. In the application context of information system (IS) continuance, Bhattacharjee (2001) integrated the concepts of TAM (Davis, 1989) into the expectation disconfirmation model to explain and analyze IS continuance behavior based on user expectations of systemic attributes. Thus, BI is included in this model. Their respective definitions are provided in Table 1, where- as the model is shown in Figure 1. Table 2 summarizes the hypotheses that were used in this paper and which had been widely adopted in numerous information system settings.

RESEARCH DESIGN

A survey agency conducted a survey to evaluate this research model in Taiwan for two months. The variables are shown in Table 1. Cronbach's value was used to test the reliability of the questionnaires and the factor analysis for convergent validity was also conducted. The results of the pilot test showed a high reliability of all the questions. All the questions used in this survey were validated. Each item of the questionnaire was measured on a 5-point Likert scale with the end points of "strongly disagree (1)" and "strongly agree (5)". The questionnaire for this study was designed to measure TAM and TPB. The measurement was developed on the constructs of PU, PEOU, attitude, SN, PBC and BI towards the

Table 1. The definition of constructs.

Construct	Definition
Behavioral intentions (BI)	An individual's intention to use the SHE application.
Attitude (ATT)	A prospective user's overall attitude towards the use of the SHE application.
Perceived usefulness (PU)	The degree to which a person believes that using SHE application would enhance his or her job performance and effectiveness.
Perceived ease-of-use (PEOU)	The degree to which a person believes that using SHE application would provide ease of use.
Subjective norms (SN)	The influence of people in an individual's social environment on his/her behavioral intentions in the SHE application.
Perceived behavioral control (PBC)	An individual's perceived ease or difficulty of exhibiting the required behavior in the SHE application.

Table 2. Hypotheses.

Hypothesis	Statement
1	Attitude positively influences behavioral intention.
2	Perceived ease of use positively influences attitude.
3	Perceived usefulness positively influences satisfaction.
4	Perceived ease of use positively influences perceived usefulness.
5	Subjective norm positively influences behavioral intention.
6	Perceived behavioral control positively influences behavioral intention.

SHE application. As shown in Table 3, PU and PEOU were both measured by using a 3-item scale adapted from Davis (1989). Attitude and BI were adapted from Wu and Chen (2005), and Taylor and Todd (1995). In specific terms, these two aforementioned pairs of constructs were measured by using a 4-item and a 3-item scale respectively. On the other hand, the measurement of TPB was based on the constructs of SN and PBC. SN and PBC were adapted from Taylor and Todd (1995); both of them were measured on a 4-item scale. The 240 participants used for this study were randomly selected from experienced mobile users. After eliminating the invalid responses through data filtering, 231 valid responses were selected as the source sample data. The results of the pilot test showed a high reliability of all the questionnaires. After data collection, a two-step procedure proposed by Anderson and Gerbing (1988) was applied during the SEM test. The first step involved developing an effective measurement model with confirmatory factor analysis, while the second step analyzed the structural model. Both SPSS 14 and AMOS 6.0 software packages were used to analyze the data.

DATA ANALYSES

Reliability and validity of constructs

Before the structural model analysis, we used Cronbach's α to verify the reliability of the measurement scale of the models'

components. The reliability can reflect the internal consistency of the indicators measured by a given factor. The item reliability for each scale was examined by using Cronbach's α to confirm the internal consistency of the measurements. Nunnally (1978) suggested that a scale can be considered to have a high reliability if Cronbach's α is greater than 0.70. Contrarily, the measured item should be ignored if the associated Cronbach's α is lower than 0.35. As shown in the results, every constructed model in this study had a strong reliability, with all Cronbach's α greater than 0.70 (Table 3). Convergent validity is achieved if the different indicators used to measure the same construct obtain strongly correlated scores. In SEM, convergent validity can be assessed by reviewing the t-tests for the factor loadings (Hatcher, 1994).

For the model used in this study, all the factor loadings of the indicators measuring the same construct are statistically significant as shown in Table 3, showing that all indicators effectively measure their corresponding constructs (Anderson and Gerbing, 1988). Therefore, this supports convergent validity. In addition, users were divided into two groups, one consisting of those who had hands-on experience with the SHE application and the other consisting of those who did not have hands-on experience. These two groups were compared to demonstrate an improved external validity for this study. The chi-square difference test can be used to assess the discriminant validity (Hatcher, 1994). Discriminant validity is demonstrated if the chi-square difference (with 1 d.f.) is significant, meaning that the model through which the two constructs are viewed as distinct, but correlated, is superior. By using the

Table 3. Summary of measurement scales.

Construct	Indicator	Factor loading	Cronbach's α	Variance extracted
Behavioral intention (BI)	BI19	0.73	0.82	0.60
	BI20	0.79	--	
	BI21	0.81	--	
Attitude (ATT)	ATT15	0.75	0.89	0.67
	ATT 16	0.86	--	
	ATT 17	0.85	--	
	ATT 18	0.80	--	
Perceived ease-of-use (PEOU)	PEOU1	0.79	0.88	0.71
	PEOU 2	0.89	--	
	PEOU 3	0.85	--	
Perceived usefulness (PU)	PU 4	0.84	0.88	0.69
	PU 5	0.89	--	
	PU 6	0.75	--	
Subjective norm (SN)	SN7	0.82	0.84	0.64
	SN8	0.75	--	
	SN9	0.82	--	
	SN10	0.48	--	
Perceived behavioral control (PBC)	PBC11	0.73	0.87	0.63
	PBC12	0.79	--	
	PBC13	0.83	--	
	PBC14	0.81	--	

model's overall goodness-of-fit: $\chi^2/\text{d.f.}$ = chi-square divided by degrees of freedom, adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), incremental fit index (IFI), parsimony goodness-of-fit index (PGFI), parsimonious comparative fit index (PCFI), parsimonious normed fit index (PNFI), and root mean square residual (RMR). As shown in Table 5, the comparison of all fit indices with their corresponding recommended values provided evidence of a good model fit (chi-square/d.f. smaller than 3.0, GFI, AGFI, CFI, normed fit index (NFI) all greater than 0.9, and RMR, root mean square error of approximation (RMSEA) smaller than 0.08). Thus, the results indicated that the measurement and structural model exhibited a fairly good fit with the data collected (Anderson and Gerbing, 1988; Hinkin, 1995; Hu and Bentler, 1995).

DISCUSSION

Based on the good model fitness described earlier, Table

6 lists the empirical test results of the research hypotheses. As can be seen, all the path coefficients of hypotheses H_1 , H_3 , H_4 , H_5 and H_6 are compliant with their significant influence at the 0.01 level except the path coefficient of hypothesis H_2 (perceived ease-of-use positively influences attitude). The summaries of the results of the hypotheses testing are as follows:

- (1) Subscribers' attitude positively affects BI of adopting SHE application and service.
- (2) PU is relevant to subscriber attitude as the functionality and effectiveness of the SHE provided predominantly influence subscribers' willingness to adopt the SHE application and service.
- (3) SN significantly influences BI as a strong social influence does affect subscribers' use and appropriation of the SHE service.
- (4) PBC positively influences BI. Subscribers' intentions of adopting the SHE service are affected primarily by the ease-of-use mechanism which enables self-proficiency.

In addition to these empirical results, there is a

Table 4. Chi-square difference tests for examining discriminant validity.

Construct pair (Unconstrained) $\chi^2= 286.8$ (d.f.= 120)	Constrained χ^2 (d.f.= 121)	χ^2 difference
(BI, ATT)	372.0	85.2***
(BI, PEOU)	372.6	85.8***
(BI, PU)	423.8	137.0***
(BI, SN)	426.0	139.2***
(BI, PBC)	371.4	84.6***
(ATT, PEOU)	385.2	98.4***
(ATT, PU)	439.7	152.9***
(ATT, SN)	452.5	165.7***
(ATT, PBC)	379.3	92.5***
(PEOU, PU)	421.0	134.2***
(PEOU, SN)	422.7	135.9***
(PEOU, PBC)	314.8	28.0***
(PU, SN)	453.6	166.8***
(PU, PBC)	409.7	122.9***
(SN, PBC)	400.9	114.1***

Notes: ***: significant at the 0.001 overall significance level when the Bonferroni method was used.

**: significant at the 0.01 overall significance level when the Bonferroni method was used.

Table 5. Goodness-of-fit indices for the model.

Fit index	Recommended value	Measurement model	Structural model	Source
$\chi^2/d.f.$	≤ 5.0	2.65	2.99	Bentler (1989)
AGFI	≥ 0.80	0.80	0.81	Anderson and Gerbing (1988) Henry and Stone (1994) Scott (1994)
CFI	≥ 0.90	0.91	0.90	Bentler and Bonett (1980) Bentler (1989) Hair et al. (1998)
IFI	≥ 0.90	0.91	0.90	Bentler and Bonett (1980) Bentler (1989) Hair et al. (1998)
PGFI	≥ 0.50	0.64	0.63	Byrne (2001) Hair et al. (1998)
PCFI	≥ 0.50	0.75	0.74	Byrne (2001) Hair et al. (1998)
PNFI	≥ 0.50	0.72	0.71	Byrne (2001) Hair et al. (1998)
RMR	≤ 0.08	0.04	0.08	Hair et al. (1998)

Note: $\chi^2/d.f.$ = chi-square divided by degrees of freedom; AGFI= adjusted goodness-of-fit index; CFI= comparative fit index; IFI= incremental fit index; PGFI= parsimony goodness-of-fit index; PCFI= parsimonious comparative fit index; PNFI= parsimonious normed fit index; RMR= root mean square residual.

Table 6. Summary of the results of hypotheses testing.

Hypothesis	Path coefficient (t-value)	Results
Hypothesis 1 Attitude positively influences behavioral intention.	0.47*** (6.38)	Supported
Hypothesis 2 Perceived ease of use positively influences attitude.	0.09 (0.69)	Not supported
Hypothesis 3 Perceived usefulness positively influences satisfaction.	0.44*** (3.37)	Supported
Hypothesis 4 Perceived ease of use positively influences perceived usefulness.	0.79*** (11.38)	Supported
Hypothesis 5 Subjective norm positively influences behavioral intention.	0.25** (3.06)	Supported
Hypothesis 6 Perceived behavioral control positively influences behavioral intention.	0.37*** (4.30)	Supported

Table 7. Latent mean difference across two groups

Group	t-value	Degree of freedom	p-value
With hands-on experience in SHE application $BI_{ave} = 3.73$	2.464	231	0.014
Without hands-on experience in SHE application $BI_{ave} = 3.45$			

significant relationship between subscriber BI and hands-on experience in SHE application. Table 7 shows that the hands-on experience of SHE application subscribers promotes the intention and willingness to adopt SHE application through recognizing its usefulness and the ease-of-use control interface. In integrating the unique features of 3G networks, over 65% of the market share of the standard windows mobile, Symbian development platform, smartphone and handset security management application service can be used to protect security data for mobile phone consumers, effectively reduce consumers' worries about the security of mobile phone data and improve consumers' acceptance and understanding of smartphones. These findings can help to develop competitive strategies for 3G value-added services and fourth generation (4G) value-added services in future.

CONCLUSION

Presently, more than 3.8 billion users adopt 3G mobile services. However, it has not performed as much as it was expected to do a decade ago. In order to find out the reason, this paper examined customers' BI of adopting 3G value-added services. We attempted to reveal the relative importance of attitude, PEOU, PU, SN and PBC in predicting mobile users' BI of adopting the latest available 3G value-added services. We found out that subscribers' attitude positively affects the BI of adopting SHE application and service; besides, PU is relevant to subscriber attitude. These findings can help ASP to correctly analyze and understand subscribers' intentions and service demand, and the needed strategies to promote their services.

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