doi:10.1111/j.1365-2575.2007.00265.x

Extending technology usage models to interactive hedonic technologies: a theoretical model and empirical test

Chieh-Peng Lin* & Anol Bhattacherjee†

*Graduate School of Technological and Vocational Education, National Yunlin University of Science and Technology, 123 University Road, Section 3, Douliou, Yunlin 64002, Taiwan. email: cplin@yuntech.edu.tw, and †Information Systems and Decision Sciences, College of Business Administration, CIS 2069, University of South Florida, Tampa, FL 33620, USA, email: abhatt@coba.usf.edu

Abstract. *Much of our prior knowledge of information systems (IS) usage is based on utilitarian systems such as personal productivity software and organizational applications. However, new generations of systems, such as online video games (OVGs), have since emerged that aim at enhancing users' hedonic outcomes like entertainment rather than utilitarian outcomes such as productivity. Prior models of utilitarian system usage provide a limited understanding of one's usage of hedonic systems, given the motivational differences between using these two types of systems. Theoretical modifications instead are required to extend the current models to hedonic systems. Expanding the research on attitude theories, we propose an initial model for usage of interactive hedonic systems, replacing perceived usefulness and perceived ease of use with perceived enjoyment and social image as the core cognitive drivers of usage, and further linking these beliefs to different technological attributes. The initial model is empirically validated using a survey of OVG usage among 485 student subjects. For IS usage research, this paper proposes and validates one of the earliest usage models of hedonic systems. For practitioners, this study provides some guidelines for manufacturers of hedonic systems on how to derive the most return on their system development efforts.*

Keywords: user acceptance of IS, IS diffusion and adoption, questionnaire surveys

INTRODUCTION

Information systems (IS) usage has been a key area of IS research for the last two decades. A given IS cannot be considered successful if it is not used by its intended users (DeLone & McLean, 1992). Prior studies in this area have identified several determinants of IS usage, such as the perceived usefulness, perceived ease of use and self-efficacy of IS usage, and

proposed several theoretical models, including the technology acceptance model (TAM), theory of planned behaviour (TPB) and social cognitive theory, to explain how these determinants are related to each other and causally influence information technology (IT) usage (see Venkatesh *et al*., 2003 for a comprehensive review). Most of these studies view IS as a utilitarian tool for enhancing user productivity, performance, or effectiveness in their personal life or in the workplace. This perspective is evident in the hypothesized determinants of IS usage, such as perceived usefulness, as well as in empirical settings where the previously mentioned models are tested, such as one's personal usage of productivity software (e.g. word processors, spreadsheets) or organizational users' usage of enterprise software (e.g. enterprise resource planning systems). Collectively, the previously mentioned models, antecedents and associations provide a reasonable understanding of why and how people use utilitarian systems.

However, with recent breakthroughs in broadband infrastructure, interactive software and wireless technologies, the scope and application of IS in today's society have expanded beyond its original utilitarian objective to also encompass non-utilitarian objectives. A new class of interactive hedonic systems has emerged that aims at enhancing users' hedonic needs such as entertainment, enjoyment and excitement rather than utilitarian needs such as productivity or performance improvement. Examples of such systems include online video games (OVGs), entertainment Web sites, online music downloads and instant messaging.

The pervasiveness and importance of hedonic systems in today's societies can be realized from the statistic that online and computer video games accounted for US$10 billion in global sales in 2004, with US$7.3 billion in the USA alone (NPD Group, 2005). Popular game genres include action/fighting games such as Mortal Kombat and Doom, role-playing games such as Spiderman and Star Wars, and sports games such as Madden NFL and NBA Jam. Entertainment giants such as Sony, BMG and Vivendi have staked their future on hedonic systems, as have traditional computer hardware and software companies such as Apple Computers and Microsoft. Today, 50% of all Americans play video games and 43% play such games online (ESA, 2005). Originally intended for children and the younger population, gamer demographics have today transcended traditional age and gender boundaries, with the average gamer being a 30-year-old full-time worker, 19% of gamers being over the age of 50 and 43% being women gamers (ESA, 2005). In the USA, gamers spend an average of 5.2 hours per week playing alone and an additional 3.1 hours playing with family and friends (BBC, 2005). Undoubtedly, this new class of systems is dramatically reshaping the way people view entertainment, socialization and leisure.

Despite the dramatic growth of hedonic systems in recent years, research focusing on the acceptance and usage of such systems has remained scant. Extant models of utilitarian system usage may not provide an adequate understanding of hedonic system usage, given motivational differences behind using these two system types, leading van der Heijden (2004) to suggest that the nature of IS is an important boundary condition to the validity of current IS usage models. Indeed, traditional systems are not built from the 'joy angle', despite users increasingly spending time online and expecting it to be a pleasurable experience (Brody, 1992). In a study of instrumental systems that had hedonic ramifications, Davis *et al*. (1992)

demonstrated that one's intention to use systems in the workplace can be guided by both extrinsic and intrinsic motivations. Extrinsic motivations concern the utilitarian outcomes of system usage such as its perceived usefulness, while intrinsic motivations concerns hedonic outcomes such as perceived enjoyment. Extending this work within the context of hedonic Web sites, van der Heijden (2004) demonstrated that perceived enjoyment and perceived ease of use are stronger determinants of intention to use hedonic systems than perceived usefulness, while the reverse pattern of effects is typically observed in the case of utilitarian system usage (e.g. Venkatesh *et al*., 2003). Van der Heijden (2004) also suggested that our prediction of system usage can be improved by considering the nature of the targeted system in addition to the inclusion of additional determinants salient to using hedonic systems.

Our study extends the work of van der Heijden (2004) by first extending from personal-usage hedonic systems to *interactive* hedonic systems such as online multi-user video games, and second, by examining which characteristics of interactive hedonic systems influence users' intention to use hedonic systems and how. It is important to note that hedonic systems can be non-interactive (e.g. entertainment Web sites, single-user games) or interactive (e.g. online chatrooms, multiplayer video games). While van der Heijden (2004) focused on the former, we decided to study the latter. Further, van der Heijden (2004) started with user cognitions and examined their effect on system usage, we explore the relationships between system attributes and user cognitions in addition to their effects on user intentions. In particular, we attempt to look inside the IS 'black box', as suggested by Benbasat & Zmud (2003), in an attempt to tailor our research model to the unique configuration of interactive hedonic systems.

To examine which system determinants influence interactive hedonic system usage and how, we start by postulating a research model of interactive hedonic systems by drawing on attitude theories in the psychology literature, such as the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975) and the TPB (Ajzen, 1991). Although these generic theories can help explain a wide range of behaviours, they require further customizations, such as elicitation of salient cognitions, to explain specific behaviours better. In their formulation of TAM, Davis *et al*. (1989) customized the TRA to explain utilitarian IT usage in the workplace, and van der Heijden (2004) tailored it further to explain hedonic IT usage. In this study, we customize the TRA to the specific case of interactive hedonic system usage by focusing on two unique attributes of such systems – their technical quality and interaction quality – and the effects of these attributes on hedonic IT usage intention via users' perceived enjoyment, social image and overall attitude towards such usage. This preliminary model of interactive hedonic IT usage can not only serve as a starting point for further research in the emerging area of hedonic systems, but can also help technology vendors (OVG developers) prioritize their development resources to designing games that are better tailored to the needs and preferences of their targeted user base.

The rest of our paper proceeds as follows. The next section presents our research model and hypotheses, along with their theoretical rationale. The third section describes an empirical study designed to test the proposed hypotheses. The fourth section presents our data-analysis techniques and results. The final section offers a discussion of these results, limitations of our study, and implications for future research and practice.

RESEARCH MODEL AND HYPOTHESES

Attitude theories in the psychology literature, such as the TRA (Fishbein & Ajzen, 1975) and the TPB (Ajzen, 1991), have long served as referent theories for IT usage research. These theories suggest that goal-directed human behaviour can be predicted primarily by people's intention regarding that behaviour, which in turn is determined by their attitude (affect) and cognitive beliefs towards the target behaviour. Although these theories do not identify specific beliefs salient for a particular behaviour, such as IT usage, they agree on the beliefs–attitude–intention–behaviour chain of causality that ultimately culminates in user behaviour, as shown in Figure 1.

The TRA suggests that one's attitude is the primary predictor of an intention regarding that behaviour. *Attitude* is defined as one's personal affect towards a target behaviour such as technology usage (Davis *et al*., 1989). The association between attitude and intention has been validated in numerous prior studies on usage of utilitarian systems (e.g. Davis *et al*., 1989) and is not likely to be any different for interactive hedonic systems. In fact, because most hedonic systems are designed to appeal to the users' affect or feelings rather than their cognition or judgement and because many personal non-work behaviours such as entertainment tend to be more affect based than cognition based in nature, the salience of attitude in explaining user usage intention may be greater for hedonic systems than for utilitarian systems. These considerations lead us to propose:

> H1: Users' attitude towards usage of interactive hedonic systems is positively associated with their intention regarding future usage of such systems.

Applying the generic TRA to the specific case of utilitarian IT usage, Davis *et al*. (1989) suggested perceived usefulness and perceived ease of use as the two key beliefs shaping one's attitude towards system usage. Perceived usefulness is defined as the extent to which potential users expect to gain performance, productivity, or effectiveness at work because of system usage, while perceived ease of use refers to the extent they expect the usage process to be relatively free of effort. While these beliefs are well established as the key drivers of attitude in utilitarian IT usage contexts (Davis *et al*., 1989), they are less likely to be salient

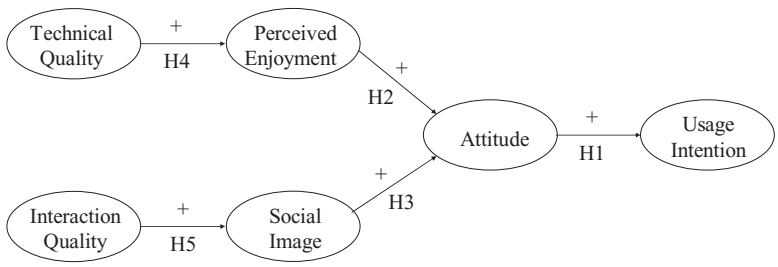

Figure 1. Research model.

predictors of interactive hedonic system usage. Perceived usefulness is less relevant for hedonic systems such as OVGs because such systems are not designed to enhance utilitarian outcomes such as improved job performance. Perceived ease of use is also less salient because hedonic systems are considerably less demanding of technical or specialized skills than utilitarian systems such as ERP systems or database systems. Hence, perceived usefulness and ease of use are both excluded from our research model of interactive hedonic IT usage (Figure 1).

If perceived usefulness and ease of use, the two most widely studied cognitions related to utilitarian IT usage, are not relevant, which cognitions are salient to explaining interactive hedonic IT usage? Among numerous cognitions examined in prior IT usage research (see Venkatesh *et al*., 2003), those that are most salient to the current context are perceived enjoyment and social image. *Perceived enjoyment* can be defined as the excitement and happiness derived from IT use (van der Heijden, 2004). This construct has been demonstrated to influence user attitudes towards utilitarian systems (for two IBM-based graphics software: Chartmaster and Pendraw) as an intrinsic motivator, even when perceived usefulness is an extrinsic motivator (Davis *et al*., 1992). Perceived enjoyment should have a stronger effect on user attitudes towards hedonic systems because the expressed intent of such systems is to maximize users' enjoyment or entertainment from their use (Childers *et al*., 2001). Conversely, if hedonic systems are perceived as being low in perceived enjoyment, then users are less likely to develop positive attitudes towards their usage. This expectation leads us to propose:

H2: Users' perception of perceived enjoyment from usage of interactive hedonic systems is positively associated with their attitude towards such usage.

The second belief salient to hedonic system usage is social image. *Social image* is defined as the extent to which users may derive respect and admiration from peers in their social network as a result of their IT usage and is demonstrated to be an occasional predictor of utilitarian systems usage (Brancheau & Wetherbe, 1990; Moore & Benbasat, 1991). Social image is however more important in the case of interactive systems, where the systems act as the media for communication and social interaction (Venkatesh *et al*., 2003; Hsu & Lu, 2004). Interactive hedonic systems may be viewed by users as a symbolic medium to portray their social image in a favourable light within their community of peers.

It is important to distinguish social image from subjective norms, a construct frequently examined in utilitarian system usage (e.g. Venkatesh & Davis, 2000; Venkatesh *et al*., 2003). Although both constructs are rooted in social influence and are overlapping to some extent (see Venkatesh & Davis, 2000), they are conceptually distinct in that subjective norms, derived from the TRA, refers to the normative influence (e.g. direct or indirect pressure) exerted by significant referent others such as peers, friends and family members on a person's intention to perform a specific behaviour (Fishbein & Ajzen, 1975), while social image, derived from innovation diffusion theory, refers to the respect and admiration that one expects to derive from referent others as a result of his or her behaviour (Lu *et al*., 2003). Subjective norm may play a role in motivating hedonic system usage; however, social image should have a significantly greater effect because power users derive a substantial amount of reputation, reverence and

prestige in their community of peers by virtue of their ability to use such systems adeptly and to help others use the systems better. For instance, in online video gaming, gamers with high scores or those at a higher gamer level receive positive attention and admiration from other gamers. This enhanced social image in turn improves their attitude towards online video gaming, thereby indirectly enhancing their intention regarding future usage. Hence, we propose:

H3: Users' perception of social image from usage of interactive hedonic systems is positively associated with their attitude towards such usage.

TAM suggests that 'external variables' may help shape user beliefs regarding usage and eventually their usage intention and behaviour but does not specifically identify any of these variables. Drawing on anecdotal evidence (e.g. Ferguson *et al*., 1999; Brady & Cronin, 2001; Cassab & MacLachlan, 2006) and on our own observations of the online video gaming industry, we propose two perceived system attributes – technical quality and interaction quality – as the key influences on user perceptions of using interactive hedonic systems. *Technical quality* refers to the technological sophistication and the availability of enhanced features in a given hedonic system, such as high-resolution displays, greater audio/video quality (e.g. surround sound) and high-definition programming, that have greatly improved the technical quality of systems such as OVGs (Gronroos *et al*., 2000). Improved technological features and capabilities embedded in hedonic systems tend to enhance users' perceived enjoyment by providing them with greater opportunities for deriving enjoyment or excitement from the usage experience, while lack of technical quality engender disappointment, lowered enjoyment perceptions and eventually less usage intentions. Although there is some empirical evidence that users perceive Web sites with high-quality graphics (technical quality) as being better than those lacking such qualities (e.g. Ghose & Dou, 1998), we are not aware of any study that has examined this relationship within the context of interactive hedonic systems. Hence, we propose:

H4: The technical quality of interactive hedonic systems is positively associated with the perceived enjoyment that users can expect from system usage.

Interaction quality refers to the extent to which a system allows individual users to cultivate, foster and maintain online relationships with others in their social network. This may include such capabilities as forming online teams, communicating with team members, chatting privately with others, sharing graphics, documents and emoticons, and so forth (Brady & Cronin, 2001; Lin & Ding, 2005). Interactive technologies such as video games, electronic mail and instant messaging have greatly altered the way users interact, communicate, and express values and opinions (Venkatesh, 1985; Venkatesh & Vitalari, 1987). Although social interaction is a human rather than a technological attribute, designers of hedonic systems nevertheless can facilitate the interaction process by building capabilities for team building, communication, socialization and discussion in their systems. High levels of interactivity, especially for those technologies such as OVGs, chat rooms and bulletin boards that are intended to be interactive

in nature, are likely to build positive attitudes among the targeted user population by providing them the means for building a positive social image among their community of peers. This expectation leads to our final hypothesis:

H5: The interaction quality of interactive hedonic systems is positively associated with the social image that users can expect from system usage.

RESEARCH METHODS

Subjects

The research hypotheses previously described were empirically tested using survey data collected from student subjects regarding their use of OVGs. Subjects were drawn from the student population of a large private university in Taiwan. We specifically recruited undergraduate students for this study because a sizable proportion of this population constitutes online video gamers. Industry surveys in the USA reveal that approximately 60% of college students use OVGs as their primary means of leisure when friends are unavailable and 20% use games as a way to meet new friends (Pew Internet & American Life Project, 2003). Industry surveys indicate that the Taiwanese OVG user population consists of 60.6% male and 39.4% female (Market Information Center, 2005) and that 30% of users play more than 4 hours per day on average and are thus considered heavily addicted to online games (Yahoo News, 2006). Among the heavily addicted gamers, 69% of them are male and the remaining 31% are female (CPRO, 2007).

A random set of classes were selected at this Taiwanese university, with the requirement that participating subjects must have had direct experience with playing at least one OVG of the action/fighting genre. This particular genre was selected because our first pilot study (discussed later) indicated that this was the most popular of all OVG genres. We distributed 1000 questionnaires to a random subject sample; 485 usable questionnaires were returned for a response rate of 48.5%. Respondents consisted of 67.8% males and 32.2% females. While 39.6% of these subjects played OVGs for more than 4 hours per week on average, 32.6% played for 3–4 hours per week and 27.8% played for less than 3 hours per week. These sample statistics were not significantly different from those of the population previously listed, suggesting the lack of sampling bias in our observed data.

Measures

Empirical data were collected via a Chinese language questionnaire survey. The survey was designed by drawing questionnaire items from pre-validated measurement scales in prior research and modified to fit the specific context of this study (i.e. online multiplayer video games). As the original scales were in English, they had to be translated into Chinese for presentation to our subjects. To test the adequacy of the translation process, a different translator was employed to convert the Chinese-language version back into English using a

back-translation technique, as recommended by Reynolds *et al*. (1993). A high degree of correspondence between items in the original English-language version and those in the back-translated version assured us that the translation process did not introduce artificial biases in our questionnaire survey.

A focus group study was conducted to examine the appropriateness of our constructs and scale items used to measure those constructs. Focus group participants were students in the same university who played OVGs regularly. These participants were asked to explain in their own words why they played OVGs and what system attributes were important in their decision to play these games. Subjects confirmed that the primary reason for their using OVGs was personal enjoyment and enhanced social image in their community of peers. Further, they agreed that the technical quality of these games (e.g. video effects, sound effects) and the extent to which it facilitated interaction with other participants in multiplayer settings were critical in their choice of specific games to play. This feedback provided us with some confidence about the adequacy of our research model.

Focus group participants were then asked to examine individual items for our six constructs of interest and comment on their readability and understandability, and recommend possible improvements to those items. As an illustration, one of their suggested modifications resulted in a social-image item: 'I am admired by friends while moving up to a higher level on [OVG name]'. Although the term 'moving up to a higher level' may be a little confusing for non-gamers and English-language gamers, it is clearly understandable to online video gamers using the Chinese language and was therefore deemed appropriate for this study.

The final questionnaire employed multiple-item 5-point Likert scales for measuring each construct in our hypothesized research model. In the questionnaire, subjects were asked to choose the specific OVG they were most familiar with and refer to that OVG while responding to each survey item. Subjects' usage intention was measured using three items adopted from Luarn & Lin (2003) that examined the extent to which subjects wanted to play a given online game. Attitude was measured using a three-item scale modified from Lin & Ding (2005) that tapped into the affective dimension of subjects' perception of OVGs. Perceived enjoyment was measured using three items modified from Koufaris (2002); this modification included adding specific OVG features into the scale items. Social image was measured using three items drawn from Roberts & Jones (2001). Technical quality was assessed using three items from Lii *et al*. (2004), which examined such technical attributes of an OVG as the audio and video quality and regularity of upgrades. Lastly, interaction quality was measured using four items modified from Choi & Kim (2004). These items captured the extent to which the OVG allowed subjects to form teams, communicate with each other, chat with each other and develop friendships. It should be noted that some of our measurement items were tailored to the specific context of OVGs of the action/fighting genre and may require change if they are to be reapplied to other types of hedonic systems. All scale items are listed in the appendix.

Following questionnaire design, we next conducted two pilot tests (prior to the actual survey) to assess the quality of our measures and improve item readability and clarity further if needed. Respondents for these tests were drawn from the student population at a different Chinese university similar to our target university, who were asked to fill out the survey questionnaire

and point out any confusing item in the questionnaire. Sample sizes for the two pilots were 62 and 108, respectively. Based on subjects' suggestions on the first pilot, a few items were slightly reworded. Data from the second pilot were analyzed using exploratory factor analysis, using the principal components technique with varimax rotation. Six factors emerged from the analysis with eigenvalues greater than 1.0, corresponding to the hypothesized factor structure, as shown in the factor matrix in Appendix B. All same-factor loadings were greater than 0.60, meeting the standard acceptance criterion for convergent validity (Hatcher, 1994). Of the 90 possible cross-factor loadings, 86 loadings were less than 0.30 (the typical acceptance criterion for discriminant validity) and the remaining four loadings had loadings less than 0.40. Furthermore, reliability analysis found each of our six constructs to have a Cronbach alpha of 0.77 or higher, fairly close to the acceptance norm of 0.80. Hence, all scale items were retained for the remainder of the study. Note that scale validation was repeated for our actual sample data via the confirmatory factor analysis (CFA) technique, as discussed next.

Measurement model

A two-step structural equation modelling (SEM) procedure proposed by Anderson & Gerbing (1988) was employed for measurement and hypotheses validation. The first step in this analysis was the CFA, for re-examining the convergent and discriminant validity of our measurement scales, while the second step focused on hypotheses testing using the structural model. The CFA measurement model demonstrated acceptable fit between the hypothesized model and observed data on a variety of goodness-of-fit indices (see Table 1). Given our large sample size of 485 and the sensitiveness of chi-squares (χ^2) to large samples, we did not consider χ^2/degrees of freedom (d.f.) as a measure of model fit. Instead, we examined the normed fit index, the non-normed fit index (NNFI), the comparative fit index (CFI) and the goodness-of-fit index (GFI), each of which equalled or exceeded 0.90, while the adjusted goodness-of-fit index (AGFI) was slightly lower than 0.90 – the recommended minimum value for assuring model fit (Bentler, 1989). Root mean square residual (RMR) was smaller than the recommended maximum of 0.05, and the 90% confidence interval for root mean square error of approximation (RMSEA) was also smaller than the recommended maximum of 0.08 (Bentler & Bonett, 1980), providing further evidence of the model's satisfactory fit.

Convergent validity was assessed by examining factor loadings for each item in our measurement model and the significance level for each loading, and the reliability and average variance extracted (AVE) for each construct. All factor loadings were statistically significant at $p < 0.001$, as seen from the *t*-statistics listed in Table 1. All loadings except one (the third item for usage intention) exceeded 0.60, the minimum required to assure convergent validity of constructs (Anderson & Gerbing, 1988; Hatcher, 1994). Given the proximity of the non-conforming factor loading (0.57) to the desired value of 0.60 and SEM's preference of having at least three items per construct, we decided against dropping the non-conforming usage intention item from further analysis. Cronbach alphas for all six constructs in our study exceeded 0.70 (see Table 1), satisfying the general requirement of reliability for research instruments. Further, the AVE for each construct exceeded 0.50 (Fornell & Larcker, 1981),

Table 1. Standardized loadings and reliabilities

Construct	Indicators	Standardized loading	AVE	Cronbach's α
Usage intention	UI1	0.79 ($t = 19.24$)	0.59	0.78
	UI2	0.90 ($t = 22.94$)		
	UI3	0.57 ($t = 12.90$)		
Attitude	AT1	0.77 ($t = 18.76$)	0.55	0.77
	AT2	0.78 ($t = 18.92$)		
	AT3	0.66 ($t = 15.13$)		
Perceived enjoyment	PE1	0.67 ($t = 14.84$)	0.50	0.73
	PE2	0.83 ($t = 18.95$)		
	PE3	0.61 ($t = 13.40$)		
Social image	SI1	0.76 ($t = 17.37$)	0.51	0.76
	SI2	0.67 ($t = 14.91$)		
	SI3	0.71 ($t = 15.89$)		
Technical quality	TQ1	0.84 ($t = 21.84$)	0.71	0.88
	TQ2	0.87 ($t = 22.97$)		
	TQ3	0.81 ($t = 20.62$)		
Interaction quality	IQ1	0.85 ($t = 21.99$)	0.64	0.87
	IQ2	0.84 ($t = 21.89$)		
	IQ3	0.79 ($t = 19.85$)		
	IQ4	0.72 ($t = 17.34$)		

Goodness-of-fit indices ($N = 485$):

$\chi^2_{137} = 471.80$ (p-value < 0.001)

NFI = 0.90, NNFI = 0.91, CFI = 0.92, GFI = 0.91, AGFI = 0.87

RMR = 0.046, RMSEA = 0.07

AVE, average variance extracted; NFI, normed fit index; CFI, comparative fit index; GFI, goodness-of-fit index; AGFI, adjusted goodness-of-fit index; RMR, root mean square residual; RMSEA, root mean square error of approximation.

suggesting that the hypothesized items captured more variance in the underlying construct than that attributable to measurement error. Collectively, the results given earlier provided adequate statistical evidence of convergent validity in our measurement scales.

Discriminant validity was assessed by chi-square difference tests between the unconstrained model – where all constructs are allowed to co-vary freely – with constrained models, where covariance between each pair of constructs is fixed at one (Hatcher, 1994). The advantage of this technique is that it allows for simultaneous pair-wise comparisons for the constructs based on the Bonferroni method. Controlling for the experiment-wise error rate by setting the overall significance level to 0.01, the Bonferroni method suggested that the critical value of the chi-square difference should be 11.58. As the chi-square difference statistics for all pairs of constructs exceeded 11.58 (see Table 2), discriminant validity was assured in our data sample.

Structural model

The second step in our analysis was to examine our structural model for the path coefficient and significance of each of our hypothesized paths and the variance explained for each of our dependent variables. The results of this analysis are presented in Figure 2.

Table 2. Chi-square difference tests

	χ^2 difference				
	Usage intention	Attitude	Perceived enjoyment	Social image	Technical quality
Attitude	129.98**				
Perceived enjoyment	240.27**	139.88**			
Social image	263.70**	141.53**	116.53**		
Technical quality	424.94**	195.19**	277.43**	302.57**	
Interaction quality	402.39**	301.39**	260.18**	292.79**	673.68**

**$p < 0.01$ (using the Bonferroni method).
Unconstrained model: $\chi^2 = 471.80$; d.f. = 137.
Constrained model: d.f. = 38 (for all models).

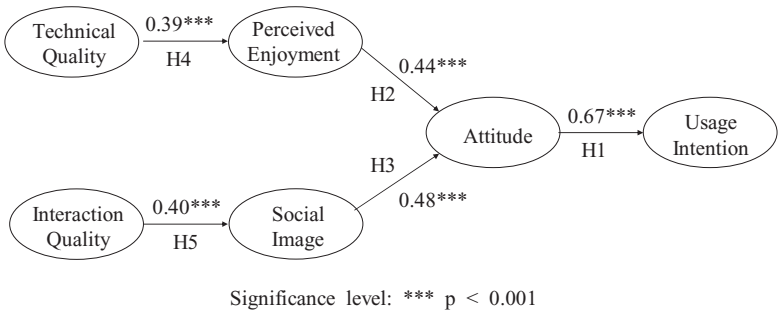

Figure 2. Structural model.

The results depicted in Figure 2 confirmed that users' attitudes towards OVGs have a strong positive effect on their intention to use such games, supporting H1. The path coefficient for this effect was 0.67 ($p < 0.001$), which explained 45% of the variance in usage intention. Perceived enjoyment and social image had independent positive effects on user attitude, supporting H2 and H3, respectively. The two predictors jointly explained 42% of the variance in attitude, with social image having a slightly larger effect ($\beta = 0.48$, $p < 0.001$) than perceived enjoyment ($\beta = 0.44$, $p < 0.001$). Technical quality had a significant positive effect on perceived enjoyment ($\beta = 0.39$, $p < 0.001$), as expected from H4, explaining 15% of the variance in perceived enjoyment. Interaction quality also had a significant positive effect on social image ($\beta = 0.40$, $p < 0.001$), as suggested by H5, explaining 16% of the variance in social image.

Because TAM proposed direct associations between cognitive beliefs such as perceived usefulness and usage intention in addition to indirect effects mediated by attitude, we next explored whether the cognitive beliefs examined in this study (perceived enjoyment and social image) had any direct effects on usage intention, over and above their indirect effects hypothesized in our research model. In the presence of indirect effects, the direct effects of perceived enjoyment and social image on usage intention were both non-significant ($p > 0.05$). Further, adding these two effects decreased the model's d.f. but did not significantly improve chi-square

or goodness of fit of the overall model. This suggested that the direct effects of these cognitive beliefs provided no additional explanation in intention to use interactive hedonic systems, unlike corresponding effects hypothesized in TAM for utilitarian systems, and that our hypothesized fully mediated model was indeed superior.

DISCUSSION AND CONCLUSIONS

Limitations of the study

The findings of our study should be interpreted in light of its limitations. The first limitation of this study is its cross-sectional research design. Clearly, system usage is a process that unfolds over time, and a cross-sectional snapshot of that process may not adequately explain the complex and dynamic interrelationships between the different cognitions related to IT usage. To examine whether the constructs and relationships proposed in this paper truly hold over time, we urge researchers to employ longitudinal research designs in future studies of interactive hedonic IT usage.

The second limitation of this study is its use of student subjects. Although college students are not uncommon subjects in academic research, particularly when the phenomenon under investigation is a common behaviour among students (Bhattacherjee & Premkumar, 2004), such sampling may nevertheless restrict the generalizability of our results to non-students or working professionals at large. Given that online gaming is a prevalent behaviour among Taiwanese college students and that a significant proportion of online games consists of college students, we hope that our specific sample did not introduce sampling bias in our observed results.

Third, given our study's specific focus on OVGs of the action/fighting genre, our findings may have limited generalizability to other interactive hedonic settings such as instant messaging, online chat and even OVGs belonging to other genres. For instance, interaction quality, a salient construct in our study, will be non-relevant in studies of single-user video game usage, where gamers do not have an opportunity to interact with or learn from other gamers. Under such circumstances (e.g., single-user videogames), adequately predicting user behaviour will require some changes in the choice of constructs and relationships, than those proposed in this study. Given that the model developed in this study was only an initial research model focusing on a new and emerging area of research in interactive hedonic IT usage, further research is necessary to examine our model's generalizability to other categories of hedonic systems such as sports, strategy, and simulation games, and possibly extend it to such contexts with the addition of new constructs and relationships.

Fourth, because our study was conducted at Taiwan, one may wonder whether our findings can be extended to Western countries or even to other Asian countries. As gamer cognitions and behaviour are often influenced by cultural differences (Crotts & Erdmann, 2000), our model and results may have to be modified with appropriate culture-based constructs such as power distance when studying gaming behaviours in other countries. As the goal of this paper

was to construct and test an initial usage model of hedonic systems usage, exploring cultural differences was beyond the scope of this study. But the role of culture may be a useful avenue for extending the current research.

Fifth, we used usage intention as our dependent variable in lieu of actual usage behaviour. While we understand that intention is not the same as and may sometimes be weakly correlated with behaviour (Straub *et al*., 1995), there was no way for us to centrally monitor subjects' usage behaviour because they played different video games at different times at different commercial Web sites. Furthermore, usage intention is widely used as a proxy of usage behaviour (Bhattacherjee & Premkumar, 2004), and hence, our use of intention as the dependent variable is not entirely unjustified.

Lastly, there may be other factors influencing gamers' intentions that were not controlled or accounted for in our proposed model, such as the service quality of the game provider (Choi & Kim, 2004), network externalities (Schilling, 2002) and personal innovativeness of the gamer (Agarwal & Karahanna, 2000). Future research may explore these factors in an attempt to expand the scope and explanatory power of our proposed model.

Implications for research

Despite the limitations, our study reports several findings of potential interest for future IS usage research. First, we provided an illustrative example of how usage models can be tailored to fit the unique requirements of specific technological contexts. Although TAM is an influential model in prior usage research and continues to provide an adequate explanation for understanding the individual use of utilitarian systems, it may not adequately explain our usage of non-utilitarian (such as hedonic) systems. Although there is a tendency and a temptation among empirical researchers to reuse established models such as TAM across all IT usage contexts without due consideration of the underlying context and nature of such usage, we suggest that such a 'one-size-fits-all' approach to modelling usage may provide a less than adequate understanding of IT usage, given intrinsic differences between varying types of systems and varying motivations for their usage. This study demonstrates how the same belief–attitude–intention paradigm that forms the basis of TAM can be tailored to other settings that TAM was not intended to explain. Such 'customization' of usage models may become increasingly important with the increasing scope and role of computer and internet systems in our lives as a means of communication, socialization and entertainment, in addition to their productivity and performance benefits.

While some prior studies have discounted the role of attitude in predicting usage intention because of the lack of an empirically significant effect (e.g. Venkatesh *et al*., 2003), our analysis found this effect to be strong and significant ($\beta = 0.67$). Although not reported here, a test for an alternative model – excluding the construct of attitude in this study – confirmed that attitude does fully mediate the effects of perceived enjoyment and social image on usage intention. Given the theoretical relevance of attitude as a key mediator in the TRA (Fishbein & Ajzen, 1975) and its established role as a predictor of attitude across a wide range of behaviours such as voting, work, and product and service purchase, we argue that it may be

premature to drop attitude from IT usage models. Although cognitive considerations such as perceived usefulness may dominate one's motivation to use utilitarian IT, our findings suggest that affective considerations such as attitude may be more important for explaining usage of non-utilitarian systems such as OVGs. Further, these findings reinforce our initial contention that the original TAM model may be ill-suited to explaining different types of IT usage and that appropriate context-sensitive customizations may be needed to understand usage behaviours better.

The two cognitive beliefs we identified and empirically validated as (indirect) predictors of usage intention of hedonic systems are perceived enjoyment and social image. The effects of these beliefs on intention are mediated by attitude. While these beliefs are distinct from perceived usefulness and perceived ease of use in TAM, they explained 42% of the variance in user attitudes in our study, which is indicative of their salience in the context of interactive hedonic system usage. There may however be other beliefs salient to this context that were not examined in this study, which may provide interesting opportunities for future research.

Our study found that social image has a slightly stronger effect on attitude ($\beta = 0.48$) than perceived enjoyment ($\beta = 0.44$) for interactive hedonic systems usage. Although social image has seen little prior examination as a predictor variable in prior usage research, related social factors – such as subjective norm – have been considered as such (e.g. Kim *et al*., 2002). While subjective norm has demonstrated a significant effect on attitude in some IT usage contexts (e.g. Karahanna *et al*., 1999), it has been less significant in other contexts (e.g. Davis *et al*., 1989), leading to its omission from TAM. This study found social factors to be relevant for hedonic systems usage, and justifiably so, because playing OVGs is indeed a social activity. Future usage researchers should exercise judgement in deciding whether or not to retain social factors in their research models, with due consideration to the social implications of the IT under investigation.

Finally, we explicated and validated two system attributes – technical quality and interaction quality – as predictors of cognitive beliefs salient to interactive hedonic systems usage. These constructs, new to IT usage research, helps open the 'black box' of information systems and explore specific system features and their relationships with the cognitive and affective perceptions that influence their usage. We demonstrated that technical quality influences user attitudes through perceived enjoyment, while social image mediates the association between interaction quality and attitudes. There may be additional such system attributes potentially relevant for system usage that are left open for future research.

Implications for practice

This study addresses several issues of potential relevance to IS vendors and managers interested in promoting system usage within their respective constituents. First, our finding that user attitude is a significant predictor of system usage intention suggests that organizational managers should routinely survey user attitudes towards system usage in order to forecast and improve their likelihood of future usage. Technology vendors, particularly those who design

hedonic systems, should recognize that user attitude is a valuable leading indicator of future success of their products or service, because an unfavourable attitude may translate into user resentment or rejection.

Second, this study observed that perceived enjoyment and social image play dominant roles in shaping user attitude and intention regarding usage of hedonic systems. Most online game vendors attempt to enhance gamer perceptions of entertainment and enjoyment by creating interesting storylines or scripts such as Superman or Spiderman, or by simulating imaginative adventures such as war games or space exploration. However, comparable or better results can be achieved by attending to gamer social-image needs such as public recognition and by rewarding high-performance or winning gamers. Managers should realize that users are motivated by the need to improve their social status within their peer network and leverage this desire to promote system usage within their organizations.

Finally, we reported that perceived enjoyment and social image can be proactively influenced through a system's technical and interaction quality, respectively. While the quality of future hedonic systems is likely to increase with newer and better technologies, improving interaction quality may require greater creativity on the part of system designers. Higher interaction quality, such as by providing support for coordinated gaming strategies among gamer teams and broadening the set of online personalities that gamers can assume, may facilitate the establishment of social image. This is more important for novice users lacking technological expertise attempting to improve their mastery of hedonic IT usage. For such users, interaction quality may provide a more effective means of improving user attitudes and intention. Fostering online relationships may also offer a good method of distinguishing the product of a particular vendor when technical quality creates a level playing field across all vendors.

In closing, this study presented an initial theoretical usage model of interactive hedonic system usage by customizing generic attitude theories in the specific context of action/fighting OVGs. The proposed model was empirically supported using a survey of OVG usage among student subjects. Hopefully, the proposed model will encourage future IT usage researchers to creatively consider how to tailor and/or extend generic IT usage models such as the TRA to derive improved explanations of IT usage in specific contexts such as interactive hedonic systems.

ACKNOWLEDGEMENTS

This work was financially supported by the National Science Council, Taiwan [NSC 96-2416-H-224-013-MY2].

REFERENCES

Agarwal, R. & Karahanna, E. (2000) Time flies when you're having fun: cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, **24**, 665–694.

Ajzen, I. (1991) The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, **50**, 179–211.

Anderson, J.C. & Gerbing, D.W. (1988) Structural equation modeling in practice: a review and recommended two-step approach. *Psychological Bulletin*, **103**, 411–423.

Benbasat, I. & Zmud, R.W. (2003) The identity crisis within the IS discipline: defining and communicating the discipline's core properties. *MIS Quarterly*, **27**, 183–194.

Bentler, P.M. (1989) *EQS Structural Equations Program Manual*. BMDP Statistical Software, Los Angeles, CA, USA.

Bentler, P.M. & Bonett, D.G. (1980) Significance tests and goodness-of-fit in the analysis of covariance structures. *Psychological Bulletin*, **88**, 588–606.

Bhattacherjee, A. & Premkumar, G. (2004) Understanding changes in belief and attitude toward information technology usage: a theoretical model and an empirical test. *MIS Quarterly*, **28**, 229–255.

Brady, M.K. & Cronin, J. Jr (2001) Some new thoughts on conceptualizing perceived service quality: a hierarchical approach. *Journal of Marketing*, **65**, 34–49.

Brancheau, J.C. & Wetherbe, J.C. (1990) The adoption of spreadsheet software: testing innovation diffusion theory in the context of end-user computing. *Information Systems Research*, **1**, 115–143.

British Broadcasting Corporation (BBC) (2005, April 8) Games overtake music for us men. [WWW document]. URL http://news.bbc.co.uk/2/hi/technology/4423365.stm

Brody, H. (1992) The pleasure machine. *Technology Review*, **95**, 31–36.

Cassab, H. & MacLachlan, D.L. (2006) Interaction fluency: a customer performance measure of multichannel service. *International Journal of Productivity and Performance Management*, **55**, 555–568.

Childers, T.L., Carr, C.L., Peck, J. & Carson, S. (2001) Hedonic and utilitarian motivations for online retail shopping behavior. *Journal of Retailing*, **77**, 511–535.

Choi, D. & Kim, J. (2004) Why people continue to play online games: in search of critical design factors to increase customer loyalty of online contents. *Cyber Psychology & Behavior*, **7**, 11–24.

CPRO (2007, January 16) The behavioral analysis of online gamers in Taiwan. [WWW document]. URL http://cpro.com.tw/channel/news/content/index.php?news_id=53748 (in Chinese).

Crotts, J.C. & Erdmann, R. (2000) Does national culture influence consumers' evaluation of travel services? A test of Hofstede's model of cross-cultural differences. *Managing Service Quality*, **10**, 410–419.

Davis, F.D., Bagozzi, R.P. & Warshaw, P.R. (1989) User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, **35**, 982–1003.

Davis, F.D., Bagozzi, R.P. & Warshaw, P.R. (1992) Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology*, **22**, 1111–1132.

DeLone, W.H. & McLean, R.R. (1992) Information systems success: the quest for the dependent variable. *Information Systems Research*, **3**, 60–95.

Entertainment Software Association (ESA) (2005, May) Essential facts about the computer and video game industry. [WWW document]. URL http://www.theesa.com/files/2005EssentialFacts.pdf

Ferguson, R.J., Paulin, M., Pigeassou, C. & Gauduchon, R. (1999) Assessing service management effectiveness in a health resort: implications of technical and functional quality. *Managing Service Quality*, **9**, 58–65.

Fishbein, M. & Ajzen, I. (1975) *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Addison-Wesley, Reading, MA, USA.

Fornell, C. & Larcker, D.F. (1981) Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, **18**, 39–50.

Ghose, S. & Dou, W. (1998) Interactive functions and their impacts on the appeal of internet presence sites. *Journal of Advertising Research*, **38**, 29–43.

Gronroos, C., Heinonen, F., Isoniemi, K. & Lindholm, M. (2000) The NetOffer model: a case example from the virtual marketspace. *Management Decision*, **38**, 243–252.

Hatcher, L. (1994) *Step-by-Step Approach to Using the SAS System for Factor Analysis and Structural Equation Modeling*. SAS Institute Inc., Cary, NC, USA.

Hsu, C.L. & Lu, H.P. (2004) Why do people play on-line games? An extended TAM with social influences and flow experience. *Information & Management*, **41**, 853–868.

Karahanna, E., Straub, D.W. & Chervany, N.L. (1999) Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly*, **23**, 183–213.

Kim, J.O., Forsythe, S., Gu, Q. & Moon, S.J. (2002) Cross-cultural consumer values, needs and purchase behavior. *Journal of Consumer Marketing*, **19**, 481–502.

Koufaris, M. (2002) Applying the technology acceptance model and flow theory to online consumer behavior. *Information Systems Research*, **13**, 205–223.

Lii, Y.S., Lim, H.J. & Tseng, L.P.D. (2004) The effects of web operational factors on marketing performance. *Journal of American Academy of Business, Cambridge*, **5**, 486–494.

Lin, C.P. & Ding, C.G. (2005) Opening the black box: assessing the mediating mechanism of relationship quality and the moderating effects of prior experience in ISP service. *International Journal of Service Industry Management*, **16**, 55–80.

Lu, J., Yu, C.S., Liu, C. & Yao, J.E. (2003) Technology acceptance model for wireless internet. *Internet Research*, **13**, 206–222.

Luarn, P. & Lin, H.H. (2003) A customer loyalty model for e-service context. *Journal of Electronic Commerce Research*, **4**, 156–167.

Market Information Center (2005, October 24). The growth of Taiwan online hedonic market continues. [WWW document]. URL http://www.eettaiwan.com/ARTP_8800379676.HTM (in Chinese).

Moore, G.C. & Benbasat, L. (1991) Development of an instrument to measure the perceptions of adoption in information technology innovation. *Information Systems Research*, **2**, 192–222.

NPD Group (2005, January) Annual U.S. video game sales. [WWW document]. URL http://retailindustry.about.com/od/seg_toys/a/bl_npd012703.htm

Pew Internet & American Life Project (2003, July 6) Let the games begin: gaming technology and entertainment among college students. [WWW document]. URL http://www.pewtrusts.com/pdf/pew_internet_gaming_0703.pdf

Reynolds, N., Diamantopoulos, A. & Schlegelmilch, B.B. (1993) Pretesting in questionnaire design: a review of the literature and suggestions for further research. *Journal of the Market Research Society*, **35**, 171–182.

Roberts, J.A. & Jones, E. (2001) Money attitudes, credit card use, and compulsive buying among American college students. *Journal of Consumer Affairs*, **35**, 213–240.

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

Straub, D., Limayem, M. & Karahanna-Evaristo, E. (1995) Measuring system usage: implications for IS theory testing. *Management Science*, **41**, 1328–1343.

Van der Heijden, H. (2004) User acceptance of hedonic information systems. *MIS Quarterly*, **28**, 695–704.

Venkatesh, A. (1985) Toward a conceptualization of the household/technology interaction. *Advances in Consumer Research*, **7**, 151–155.

Venkatesh, A. & Vitalari, N. (1987) A post-adoption analysis of computing in the home. *Journal of Economic Psychology*, **8**, 161–180.

Venkatesh, V. & Davis, F.D. (2000) A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*, **46**, 186–204.

Venkatesh, V., Morris, M.G., Davis, G.B. & Davis, F.D. (2003) User acceptance of information technology: toward a unifying view. *MIS Quarterly*, **27**, 425–478.

Yahoo News (2006, March 21) The online game market will ascend to ten billions next year. [WWW document]. URL http://tw.news.yahoo.com/060321/4/2yjz7html (in Chinese).

Biographies

Chieh-Peng Lin is an Associate Professor in the Graduate School of Technological and Vocational Education, National Yunlin University of Science and Technology, Taiwan. He received an MBA from the National Sun Yat-sen University and a PhD degree from the Institute of Business and Management, National Chiao Tung University, Taiwan. His research interests focus on the behavioural science in the context of IT. His work has been published in a variety of journals including *Asian Journal of Social Psychology*, *International Journal of Service Industry Management*, *Journal of Business Ethics*, *Journal of Organizational and End User Computing*, *Journal of Business and Psychology*, *Personnel Review* and so on.

Anol Bhattacherjee is a Professor of Information Systems in the College of Business Administration at the University of South Florida. His research interests are diffusion and use of IT innovations, applications of IT in healthcare and knowledge transfer in social networks. His research has been published in *MIS Quarterly*, *Information Systems Research*, *Journal of MIS*, *Decision Sciences* and various other journals. Anol holds PhD and MBA degrees from the University of Houston, and MS and BS degrees from the Indian Institute of Technology (India). He also serves in the current editorial board of *MIS Quarterly*.

APPENDIX A. MEASUREMENT ITEMS

Construct	Indicators
Technical Quality	[OVG name] has good sound effects.
	[OVG name] has sound video effects.
	[OVG name] is upgraded regularly.
Interaction Quality	[OVG name] allows gamers to form groups (i.e. teams or cyber families) to play together.
	[OVG name] provides efficient methods for communicating with others online.
	I am able to develop friendships with others on [OVG name].
	I openly chat with others on [OVG name].
Perceived Enjoyment	I obtain a strong sense of vigor when I defeat monsters on [OVG name].
	I feel powerful when I accomplish certain tasks on [OVG name].
	I feel excited by acquiring more skills while playing [OVG name].
Social Image	I get more respect from others when achieving some tough missions on [OVG name].
	I get admired by friends while moving up to a higher level on [OVG name].
	In all honesty, I like to impress others by showing how good I am at playing [OVG name].
Attitude	I have a favorable attitude towards [OVG name].
	I am pleased to play [OVG name].
	[OVG name] is interesting.
Usage Intention	I will play [OVG name] more compared to other games.
	I would rather first play [OVG name] whenever I am free to play online games.
	Even if close friends recommended other games, I would not change my preference for [OVG name].

OVG stands for online video game.

APPENDIX B. FACTOR MATRIX FROM PILOT TEST

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
UI1	0.021	0.055	**0.787**	0.198	0.256	0.192
UI2	0.043	0.057	**0.858**	0.059	0.123	0.271
UI3	0.281	–0.116	**0.707**	0.264	–0.040	0.111
AT1	–0.074	0.219	0.020	0.348	0.207	**0.718**
AT2	0.119	0.081	0.268	0.145	0.177	**0.803**
AT3	0.123	0.109	0.384	–0.035	0.073	**0.726**
PE1	0.051	0.132	0.336	0.369	**0.681**	0.149
PE2	0.264	0.018	0.000	0.046	**0.849**	0.178
PE3	–0.017	–0.058	0.119	0.144	**0.871**	0.102
SI1	0.159	0.059	0.068	**0.795**	0.229	0.112
SI2	0.047	–0.075	0.171	**0.817**	–0.023	0.020
SI3	0.073	0.137	0.191	**0.728**	0.260	0.239
TQ1	0.228	**0.837**	–0.024	0.118	0.011	0.165
TQ2	0.041	**0.914**	0.037	–0.024	0.044	0.068
TQ3	0.098	**0.922**	0.016	0.006	–0.018	0.087
IQ1	**0.825**	0.167	0.315	0.119	0.084	0.006
IQ2	**0.868**	0.126	0.152	0.086	0.169	–0.057
IQ3	**0.898**	–0.024	0.104	0.038	0.017	0.088
IQ4	**0.802**	0.177	–0.196	0.065	0.035	0.140
Cronbach's α	0.81	0.77	0.82	0.78	0.90	0.89

Based on principal components technique with varimax rotation.

Legend: UI = Usage Intention; AT = Attitude; PE = Perceived Enjoyment; SI = Social Image; TQ = Technical Quality, IQ = Interaction Quality.

APPENDIX C. CORRELATION MATRIX FROM SURVEY DATA

Item	UI1	UI2	UI3	AT1	AT2	AT3	PE1	PE2	PE3	SI1	SI2	SI3	TQ1	TQ2	TQ3	IQ1	IQ2	IQ3	IQ4
Mean	3.66	3.68	3.33	3.64	3.61	3.61	3.38	3.57	3.37	3.81	3.73	3.39	3.64	3.50	3.66	3.73	3.63	3.56	3.82
Std Dev	0.90	0.90	0.91	0.77	0.79	0.89	0.95	0.97	1.16	0.89	0.88	0.94	0.92	0.94	0.91	0.87	0.85	0.88	0.80
UI1	1.00	0.73	0.40	0.42	0.43	0.31	0.24	0.28	0.27	0.22	0.28	0.20	0.18	0.17	0.19	0.17	0.13	0.23	0.18
UI2		1.00	0.51	0.48	0.50	0.36	0.27	0.30	0.24	0.23	0.37	0.24	0.23	0.23	0.26	0.21	0.22	0.27	0.22
UI3			1.00	0.38	0.49	0.36	0.25	0.19	0.22	0.20	0.31	0.30	0.16	0.18	0.17	0.24	0.26	0.30	0.29
AT1				1.00	0.64	0.45	0.33	0.38	0.29	0.41	0.38	0.45	0.36	0.31	0.36	0.17	0.22	0.21	0.28
AT2					1.00	0.50	0.32	0.36	0.32	0.30	0.34	0.32	0.34	0.33	0.36	0.19	0.23	0.30	0.31
AT3						1.00	0.25	0.36	0.31	0.28	0.23	0.25	0.50	0.49	0.49	0.27	0.31	0.32	0.35
PE1							1.00	0.56	0.33	0.39	0.26	0.53	0.15	0.15	0.24	0.19	0.15	0.19	0.27
PE2								1.00	0.53	0.35	0.20	0.36	0.23	0.24	0.25	0.27	0.28	0.32	0.34
PE3									1.00	0.32	0.25	0.25	0.21	0.22	0.19	0.20	0.19	0.19	0.24
SI1										1.00	0.55	0.52	0.28	0.22	0.27	0.25	0.26	0.18	0.26
SI2											1.00	0.46	0.21	0.21	0.20	0.16	0.14	0.19	0.20
SI3												1.00	0.15	0.17	0.17	0.23	0.20	0.25	0.24
TQ1													1.00	0.74	0.67	0.23	0.26	0.21	0.30
TQ2														1.00	0.71	0.21	0.24	0.22	0.23
TQ3															1.00	0.24	0.26	0.19	0.28
IQ1																1.00	0.74	0.66	0.58
IQ2																	1.00	0.65	0.59
IQ3																		1.00	0.60
IQ4																			1.00

