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The convergent use of mobile phones: A comparison of user behaviors between Australia and Taiwan

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The emergence of device convergence with regard to new design and data services have transformed the use of mobile phones from solely for voice and text communication into various purposes, namely personal information management (PIM), entertainment, e-mail communication, and commercial transactions. However, most of the existing literature on mobile technology adoption has thus far focused on the adoption of mobile phone as a single function device and hence does offer very limited explanatory power to understand the utility of mobile phone as a converged device. In addition, the scope of previous studies has been limited to a single country. Therefore, this paper intends to address both these limitations. The aim is to explain the use of mobile phone as a converged device and the determinants that influence such use. Data were collected based on a cross-national survey in Australia and Taiwan. Although the findings indicate that the individual profiles and usage patterns in both countries are similar, the empirical framework explains more variances in the Australian sample. Among the psychometrical factors, individuals' perception of enjoyment is the dominant factor that drives people to use mobile phones for various purposes in both Australia and Taiwan. Users' age does differentiate the use of mobile phones for different purposes in both samples. Gender seems to have some influence as well. Male and female users show significant differences in using their mobile phones for entertainment, e-mail and commercial transactions. The findings also pinpoint the effects of individuals' perceptions, demographics, and technology choices are heterogeneous when using mobile phones for specific purposes. Some effects, such as risk and enjoyment can be explained by cultural differences. Therefore, product manufacturers and service providers should dedicate their marketing efforts in accordance to match with the heterogeneous demand from their customers.

Key words: TAM, mobile commerce, moderating effect, logistic regression.

INTRODUCTION

Due to the convergence of communication networks, information services and end-user technologies, the design and use of mobile phones have exceeded the traditional utility of voice communication to incorporate utilities from information, transaction and marketing interaction (Balasubramanian et al., 2003; Bouwman et al., 2008). However, on the proposition of mobile service adoption, many researchers have found different patterns when people use various advanced services from their mobile phones in different countries (Anckar and D'Incau, 2002; Kim, et al., 2004; Verkasalo, 2008). For marketing new mobile devices and services, it is also risky for decisions of financial investment and marketing strategy if business providers do not understand the benefits and demand that users expect from advanced mobile technology (Shin, 2007).

For better understanding of mobile user behaviour, researchers from social informatics have contributed to the evidences by observing the uses of mobile phones and make connection with the changes of people's social

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Table 1. Individual purposes and activities from the use of mobile phones.

Individual purpose	User activities
Personal Information Management (PIM)	Setting as alarm clock; making daily schedule; taking notes
Entertainment	Listening to music; watching a video clip ; playing games
E-mail communication	Sending to friends; sending for business contacts
Commercial transactions	Checking bank account; paying bills; doing shopping

life (Palen, 2002). Another stream of researchers adapted Information technology (IT) disciplines (for example, TAM) to understand why people adopt a new mobile technology (or device) or a cluster of mobile services. However, as more technology features and versatile services are embedded to expand the capacity and utility of a mobile phone, the existing frameworks may have limitation to specify both how and why individuals use mobile phones in terms of individual differences and use contexts. In addressing this problem, the following research questions were raised.

Research questions

(i) For what purpose do people use their mobile phones?
(ii) What are the influences of moderators in the use of mobile phones for a specific purpose?
(iii) Is there any difference between Australian and Taiwanese users in terms of determinants and user behaviours?

Besides, extending from the author's previous work (Chang, 2007), this research intends to verify four empirical frameworks based on the sample population in Australia and in Taiwan. The four purposes and related behaviours become the dependent variables in this research (Table 1).

In a broad context, the research instrument and data analysis are based on the data collected in Australia and in Taiwan which also represent the cross-comparisons of user contexts between Western and Eastern societies.

The market of mobile phone in both countries have achieved high penetration rate on mobile phone adoption (that is, over 100%) and have a rapid growth of launching the latest mobile devices and mobile data services (for example, 3G and WiFi). Although the market offering and service usage are prevalent, the consumer demands for advanced mobile handsets and versatile mobile data services (MDS) were still below the expectation of device manufacturers and service providers in a global scale (Oh et al., 2008). Many global service providers are still looking for a profitable business model for new mobile applications and technology innovations (Funk, 2005). Hence, to overcome the barrier of new user experiences and incremental consumer demand, some researchers also urged to unveil the user demand from the provision of advanced mobile devices and services, which in turn becomes the key to the success of this new market segment (Hong and Tam, 2006; Shin, 2007).

LITERATURE REVIEW

Technology acceptance Model (TAM), among the other models of technology adoption, such as Diffusion of Innovation (DOI) (Rogers, 2003) and Theory of Planned Behaviour (TPB) (Ajzen, 1991) was widely applied to predict the acceptance of new technology as well as to explain IT usage in the working contexts (Davis, 1989). Contingent studies of TAM have also been undertaken in different user contexts, technology types and countries (Lee et al., 2003). However, regardless of its theoretical and predictive robustness, TAM has also been criticised by a number of researchers for limited effects from two instrumental beliefs (Mathieson, 1991; Taylor and Todd, 1995) and having low explanatory power to explain the relationship between usage intention and actual usage (Benbasat and Barki, 2007; King and He, 2006; Lee et al., 2003; Ma and Liu, 2004). There are critical factors which are largely omitted in the framework of TAM (Legris et al., 2003).

To overcome the limited explanation of TAM, empirical researchers attempted to improve TAM by specifying the user contexts (Venkatesh et al., 2003), incorporating more research constructs (Lee et al., 2003), and considering the effects of moderators in their frameworks (Schepers and Wetzels, 2007; Sun and Zhang, 2006). However, such extensions have seldom been tested in the mobile contexts and contrasted simultaneously in a number of countries, especially the users with different cultural background. Some research either synthesised the cultural dimensions into the framework of TAM and compared the technology adoption in different countries (Straub et al., 1997; Straub, 1994) or examined an empirical framework across different countries, such as in Asia (Kim et al., 2004; Zhang et al., 2010) and in Europe (Vrechopoulos et al., 2003). However, their studies were mostly attributed to the domain of m-commerce. Hence, this research undertakes the second approach by choosing two countries (that is, Australia versus Taiwan) with diverse cultural background. In addition, the scope of this research not only focuses on a general mobile technology adoption but also intends to explore the uses of mobile phones from other domains, such as information, e-mail communication and entertainment.

A number of researchers also applied TAM as a theoretical basis to develop their empirical models and form as the determinants that influence individuals to adopt different mobile devices (for example, WAP phone, handheld device) (Sarker et al., 2003; Teo and Pok, 2003) and various mobile services (for example, 3G, WAP, m-commerce) (Hung et al., 2003; Liao et al., 2007; Pagani, 2004; Wu and Wang, 2005). However, due to the emerging technology convergence and service provisions on a mobile phone, empirical research has limitations to: (1) explore the determinants of using different technologies and services from a converged device rather than the adoption decision of technologies and services in a wide range; (2) explicate the effects of user characteristics and individual capabilities; (3) the versatile purposes and activities from the use of mobile phones. A holistic framework which includes various purposes and moderating effects is anticipated to overcome the above limitations and makes contribution to the knowledge of future research.

The justification of research indicators

During the exploratory stage of TAM, researchers were interested in unveiling the orientation and effects of two factors, namely perceived usefulness (PU) and perceived ease of use (PEOU), and validating their effects on explaining the intentions towards technology adoption (Karahanna and Straub, 1999). Based on the motivation theory (Deci and Ryan, 1985), PU was assumed to capture an individual's expected outcome from performing certain behaviour, such as receiving both tangible (monetary) and intangible (expectancy) rewards. Hence, this assumption can be referred to an individual's extrinsic motivation (Davis et al., 1992; Deci and Ryan, 1985). Teo et al. (1999) defined extrinsic motivation as "*the performance of an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself.*" Rresearchers also acknowledged the effect of extrinsic motivation may not fully dictate the individual perceptions and behaviours and suggested for reviewing another psychological domains from the individual's intrinsic motivation (Davis et al., 1992).

In contrast to extrinsic motivation, intrinsic motivation was defined as "the performance of an activity for no apparent reinforcement other than the process of performing the activity per se" (Teo et al., 1999). This notion can be used to present the 'ease of use' dimension. Venkatesh and Davis, 1996; Venkatesh 1999, 2000, reiterated the psychological origin of perceived ease of use and applied this construct to explicate the role of intrinsic motivation in technology adoption. Hence, individuals' perceptions of ease of use and usefulness are thus regarded as deriving from intrinsic and extrinsic motivation during the process of system interactions. However, several researchers also found PU is more stable and consistent in explaining one's behavioural intention (BI) than PEOU (Karahanna et al., 1999; Legris et al., 2003). Given the high penetration of mobile phone adoption and relative user experiences in both countries, PEOU may not be a suitable construct for mobile phone users in both countries and should be excluded. Hence, the research hypothesis of perceived usefulness is illustrated.

H1. Perceived usefulness (PU) will have significant influences on the use of mobile phones for PIM, entertainment, e-mail communication and commer-cial transactions.

In contrast to the utilitarian benefits and outcomes from PU, a list of researchers also found perceived enjoyment as a critical indicator in their measurement to predict individuals' intention of personal computer acceptance and usage (Davis et al., 1992; Igbaria et al., 1996), adoption of group support system (GSS) (Chin and Gopal, 1995), adoption of Internet (Teo et al., 1999) and web-based system (Yi and Hwang, 2003). Perceived enjoyment was defined as "the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences (Davis et al., 1992)." Researchers also consider the effectiveness of applying perceived enjoyment to explain individual behaviours for seeking of hedonic characteristics from the consequences of technology adoption (van der Heijden, 2004). The measures of perceived enjoyment often consisted of three to seven dimensions, such as fun, pleasant, exciting, enjoyable, and so forth. Therefore, it is presumable that the more enjoyment individuals perceive the more likely they will use the technology.

Besides, perceived enjoyment and perceived playfulness were often interchangeable in the study of online behaviour (Webster and Martocchio, 1992; Webster et al., 1993). While different from the measure of perceived playfulness which is dedicated to study the effect of human-computer interaction within an online environment, perceived enjoyment was more pertinent to measure the general affection as a contrast to the utilitarian perceptions on influencing the consequences of technology adoption. Hence, the following hypothesis:

H2. Perceived enjoyment (PE) will have significant influences on the use of mobile phones for PIM, entertainment, e-mail communication and commercial transactions.

In addition to the dichotomous selection from utilitarian and hedonic domains, the factor of risk was stemmed from uncertainty as people may feel when making a purchased decision and action. The components that form the perceptions of uncertainty are illustrated as the situation that individuals feel uncertainty towards the outcomes of functional/economic or psycho/social loss

Table 2. The effects of age and gender.

Subject	Author(s)	Conclusion
Age	Morris and Venkatesh (2000)	The effect of worker's age on social norms and ease of use is verified
	Brown (2001)	The effect of work's age on competency and learning is verified
Gender	Gefen and Straub (1997)	The effect of gender on the perception and use of e-mail is verified
	Venkatesh and Morris (2000)	Men is more pertained to usefulness and women is subject to ease of use and social norms

(Taylor, 1974). Hence, the risk perception is assumed to be more intensive when people consider the services are received or delivered within online environment. Several researchers also adapted the construct of perceived risk as an antecedent factor that influences one's perceived usefulness and intentions toward online transactions (Chan and Lu, 2004; Featherman and Fuller, 2002; Forsythe and Shi, 2003). Other researchers shared their opinions about the dimensions of risk specifically when explicating the individuals' decision towards service purchasing or consumption, such as Garner (1986), Ho and Ng (1994), and Featherman and Pavlou (2003).

Chan and Lu (2004) in their study of online banking defined the construct of perceived risk as "the uncertainty that a potential adopter (or user) faces when he/she cannot foresee the consequences of his/her adoption/ continue-to-use decisions." It is agreed that perceived risk is a critical factor when it dedicates to explain the individuals' determination of performing online transactions (Bauer et al., 2005; Cho, 2004; Wu and Wang, 2005). Despite the technical complexity and alternatives that may influence people's decision towards online transactions, it is possible to assess the level of risk that specifies the use of mobile phones for commercial transaction services, such as banking, bill payment, and shopping. Hence, this study adapted the measurement scales by Chan and Lu (2004) and chose security, privacy, institutional trust and financial loss to assess the level of risk when users consider using mobile phone for commercial transactions.

H3. Perceived risk (PRISK) will have significant influences on the use of mobile phones for commercial transactions.

The introduction of moderating effects

Due to the provisions of consumer device and service usage, the usage patterns of new mobile devices and services are assumed to be heterogeneous (Gilbert and Han, 2005; Mort and Drennan, 2005). Demographic factors, such as age, gender, education and occupation were referred to segment the user groups based on their different perceptions toward technology (Gefen and Straub, 1997; Venkatesh et al., 2003; Venkatesh and Morris, 2000) (Table 2).

More specifically to the adoption of mobile technology, some studies also applied such segmentation, such as age (Oh et al., 2008; Pagani, 2004) and gender (Debaillon and Rockwell, 2005; Nysveen et al., 2005) to specify the relationship between individuals' perceptions and usage patterns of mobile services. However, as noted by Burton-Jones and Hubona (2006), Yi et al. (2005, 2006), and Yang (2005), the antecedent factors of age and gender did not provide direct evidences to explain the subsequent usage intentions and system usage. Instead, these qualitative variables, as suggested by Sun and Zhang (2006), are more appropriate to act as moderators which intervene within the causal relationship between individuals' attitude and behaviour in technology adoption research. As noted, due to the lack of direct evidence that shows connection between individual demographics (that is age and gender) and perceived risk (PRISK), such relationship is thus excluded from the hypotheses respectively.

Hence, the hypotheses of moderating effects between age and gender are formulated as:

H4. Age will significantly moderate individuals' perceptions (that is, PU and PE) toward using mobile phones for PIM, entertainment, e-mail and commercial transactions.

H5. Gender will significantly moderate individuals' perceptions (that is, PU and PE) toward using mobile phones for PIM, entertainment, e-mail and commercial transactions.

Comparing to the demographic factors in studying the technology adoption, the effects of individuals' choices of phone type and service plan are seldom conceived. Researchers, such as Bouwman et al. (2007) considered phone type and service plan as a bundle, but they did treat them as separate predicators in their models. In contrast, the factor of reference pricing from another study by Blechar et al. (2006) did not isolate the effects of individual choices from the effects of mobile user behaviour. In general, many technology studies often attributed the individuals' device adoption and service contract as the references or ignore their effects from the decision process. On the other hand, device capacity and service cost should be referred as different factors that

either facilitate or inhibit the use of mobile data services (Bina et al., 2008; Pagani, 2004; Sarker and Wells, 2003). However, individuals' choices of phone type and service plan are pre-determined before the users aware of what they can do from the point of using mobile phones. The two factors are assumed to determine the individuals' capabilities to use mobile phones for either device-oriented (for example, listening to mp3 music or playing a game) and service-oriented activities (for example, checking bank account). For example, users generally do not consider choosing certain service plan (for example, 3G or GPRS) affect their uses of mobile phones for managing their personal information and listening to music where service connection is un-necessary. In addition, similar to the effects of age and gender, phone type and service plan cannot be used as moderators in the relationships between perceived risk (PRISK) and convergent use of mobile phones. Therefore, exclusive from the psychometrical factors, the choices of phone type and service plan are assumed to indirectly associate with the individual's capability and cost from the utilisations of mobile phones based on different purposes.

H6. The choices of phone type will significantly moderate individuals' perceptions (that is, PU and PE) toward using mobile phones for PIM, entertainment, e-mail and commercial transactions.
H7. The choices of service plan will significantly moderate individuals' perceptions (that is, PU and PE) toward using mobile phones for e-mail and commercial transactions.

Acknowledged from the innovation diffusion theory (IDT) (Rogers, 2003) and from exploratory interviews (Chang, 2007), the effect of technology cluster is also supported by a number of researchers as a potential factor that explains the adoption of different information and communication technologies (Atkin and Jeffres, 1998; Dupagne, 1999; Kim, 2003; Liu et al., 2008; Yang, 2005). In addition to the benefits from complementary technologies, prior experiences and knowledge of the ownership of other technologies might reinforce the individual perceptions toward utilitarian value and outcomes (Gefen, 2003; Kim, 2008; Oh et al., 2003). Hence, the following hypothesis is proposed as:

H8. The device ownership will significantly moderate individuals' perceived usefulness toward using mobile phones for PIM, entertainment, e-mail and commercial transactions.

After illustrating the research hypotheses, different concep-tual models are developed based on the interrelationship between 3 research predicators and 4 criterion behaviours. Five moderators are also included to complement the explanation of research findings (Figure 1).

RESEARCH METHODOLOGY

According to a report by IBISWorld 2007, the majority of mobile phone users in Australia are aged from 18 to 49 years old (Oh et al., 2008). Market forecast in both locations assumed generation Y would be the potential adopters of value-added mobile services. Hence, several antecedent studies also took university students as their samples because students' age and usage pattern in this group were expected to be more representative and have relative experiences than the samples from the whole population of mobile phone users (Aoki and Downes, 2003; Brunner and Kumar, 2005; Lee, 2005; Lu et al., 2005).

This study utilised online questionnaire and snow ball sampling to collect samples from the universities in both Australia and in Taiwan. The survey commenced in a four-week period from 15, December, 2007 to 18, January, 2008. A brand new mobile phone was provided as an incentive for recruiting volunteers. To avoid sampling errors, the survey invitations were only distributed to libraries, computer labs, and bulletin boards in the school campus (Dillman, 2007). As noted, due to the limitation of convenient sampling, the response rate could not be precisely obtained (Corbitt et al., 2003; Mort and Drennan, 2005). Instead, the increase of effect size and targeted sample population are of more interest to this research.

The online questionnaire consisted of three sections: The first section of questionnaire conveyed the individuals' choices of phone type and service plan and individual activities from the use of mobile phones. Three types of mobile phone handsets (that is, basic, advanced and multifunctional) and four different service plans (that is, prepaid, voice cap, data cap, and 3G) were the options in the questionnaire. The existing use of mobile phones, such as listening to music, making daily schedule, and e-mail to friends were inquired from respondents. These activities were commonly referred in the prior research of mobile applications and services (Anckar and D'Incau, 2002; Carlsson et al., 2005; Pagani, 2004). The diverse purposes from the underlying user activities could be categorised into four dimensions, such as personal information management (PIM), entertainment, e-mail communication, and commercial transactions. This segmentation not only consists of both device utilisation and service consumption but also explicitly illustrates the use of mobile phones for multiple purposes.

Under each dimension, each activity is measured by a dichotomous response and converted as adopters (coded as 1) and non-adopters (coded as 0) based on different purposes. As Shih et al. (2010) suggested, segmenting user and non-user is critical in verifying the relationships between antecedent factors and use intention. The responses associated with the psychometrical factors (that is, PU, PE and PRISK) were measured by 7-point Likert scale, ranging from strongly agree to strongly disagree. As noted, the option of not available (N/A), as recommended by Dilman (2007), is implemented in the questionnaire to exclude the respondents who were not capable of providing appropriate responses and thus provide a more accurate result. For example, in common practices, respondents who choose mobile phones with basic functions should not be able to use their phones for sending e-mail and conducting online transactions. The final section of the questionnaire was used to inquire the demographic profiles of respondents, such as age, gender, education and occupation. Each demographical question was measured by either nominal or interval scales.

Descriptive analysis

249 cases from Australia and 258 cases from Taiwan completed the survey. 3 cases were dropped from Australian samples (N=246) and 7 were excluded from Taiwanese samples (N=251) due to the age of respondents is not qualified as young university students. In

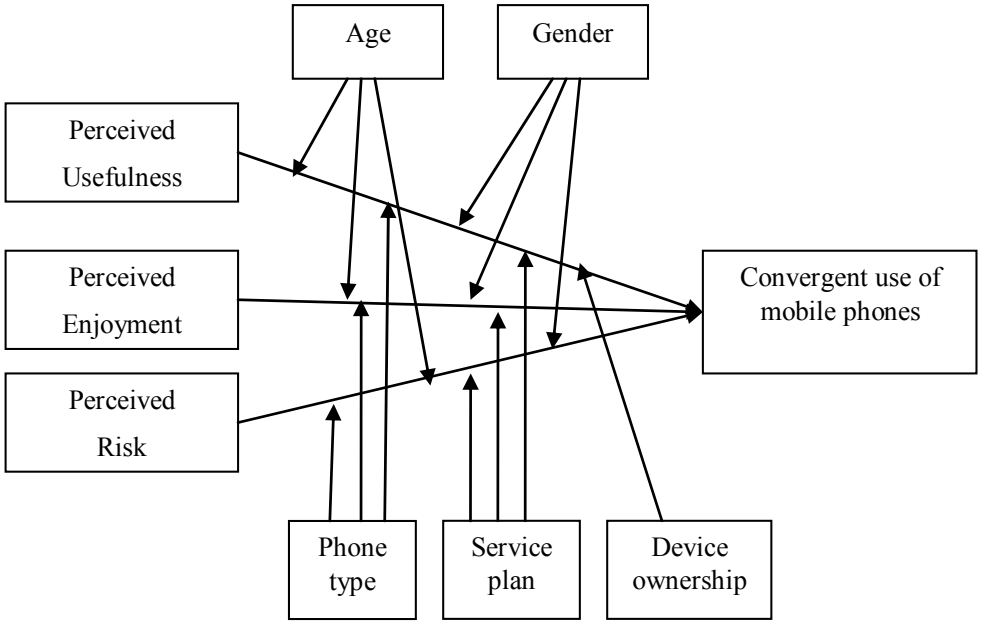

Figure 1. Conceptual model.

Table 3. Individual demographics in Australia and in Taiwan.

Demographic information	Australia (%)	Taiwan (%)
Age		
18 to 35	89.8	96.1
36 to 50	7.8	3.5
51 +	2.4	0.4
Gender		
Male	72.4	42.6
Female	27.6	57.4
Education		
TAFE	17.1	4.7
Undergraduate	50.4	91.1
Postgraduate	36.6	4.3
Occupation		
Student	80.5	86.5
Workers	4.8	5.6
Non-Workers	14.7	11.9

Table 2, it is clearly noted that the majority of respondents are drawn from university students whose age ranged from 18 to 35 years old. The ratio of gender and education are different between both samples. The percentage of male and female is nearly equal in Taiwanese samples and the ratio of respondents in Australian samples is proximately 3 to 1 (male vs. female). Most of the respondents in Taiwan were composed by undergraduate students whose age average is younger than the Australian samples (Table 3).

In Table 4, 64.9% respondents own advanced mobile devices (that is, mobile handset with the functions of camera, mp3 player, game, and GPRS connection) in Taiwan which is higher than the samples in Australia (41.5%). On the other hand, the ratio of respondents who use advanced mobile devices (multifunctional) in Australia is higher than their counterparts (30.9% vs. 12.0%). It means more Australian respondents can afford to buy advanced mobile phone handsets. The reason is perhaps the average of age and education levels of Australian samples are higher than the samples in Taiwan and Australian respondents may have more disposable incomes than the Taiwanese samples as more Australian students have part-time jobs. Another possible explanation is Australian students are more interested in purchasing advanced mobile devices than Taiwanese students.

In addition, more respondents chose voice-cap plan in Taiwan compared to most of the users in Australia who subscribed to prepaid mobile services. The reason is conceivable as most telecommunication providers in Taiwan charge their customers on a monthly basis and have less promotion on the prepaid services than the service providers in Australia. Australian respondents on the other hand may be constrained by their capacity to access to various data services if they do not upgrade to cap plan or 3G data plan (Table 5).

In Table 6, respondents in Australian samples own more digital devices than the Taiwanese samples. This result may also reflect to the differences of disposable incomes between university students in two locations.

The ratios between user and non-user in Australian and Taiwanese samples are similar (Table 7). The majority of respondents in both countries favour the use of mobile phones for managing personal information and entertainment as both of activities are related to device uses. Respondents in both countries have not yet experienced the new services from the use of mobile phones for e-mail communication and commercial transactions as both applications are service oriented.

Table 4. Device choice in Australia and in Taiwan.

Phone type	Australia (%)	Taiwan (%)
Basic	27.6	22.1
Advanced	41.5	65.9
Multifunctional	30.9	12.0

Table 5. Service subscription in Australia and in Taiwan.

Service plan	Australia (%)	Taiwan (%)
Pre-Paid	47.2	4.7
Cap Voice/SMS	24.4	50.8
Cap 2G	14.2	19.8
3G	14.2	24.8

Table 6. Ownership of other portable devices.

Device ownership	Australia (%)	Taiwan (%)
Non-owner	2.8	2.7
1 to 3	49.6	62.0
4 to 6	47.6	35.3

Instrument validation

Validity of the empirical models was analysed in two stages as suggested by Anderson and Gerbing (1988). For datasets obtained in two different locations, Principle component analysis (PCA) and varimax rotation are chosen to examine the internal validity and reliability of the measures. For exploratory research, the cut-off value for factor loadings is set to 0.50 and no cross-loading is found in the factorial matrix in the dataset (Hair et al., 2006). Three psychometrical factors (that is, usefulness, enjoyment, and risk) are identified from the factorial structure and composed as independent indicators. Their relationships are verified with four different use purposes, namely personal information management (PIM), entertainment (ENT), e-mail communication (EMAIL) and commercial transactions (COMM). The factor analysis is repeated in the datasets from both samples and the results reveal a similar factorial structure.

Item reliability was also performed by using Cronbach's alpha (>.80) as cutoff criteria (Nunnally, 1978). The reliability coefficient for all measurement items obtaining from both samples were over 0.85 which indicates the measurement scales maintained adequate internal consistency reliability (Lance et al., 2006). However, as suggested by Hair (2006), more rigorous tests are recommended for obtaining construct reliability and validity.

Confirmatory factor analysis (CFA) is used to examine the construct validity and reliability. Convergent validity was verified from the square root of factor loading of each item and no item value is below 0.50 (Anderson and Gerbing, 1988). Discriminant validity is also satisfied by the correlation among research indicators and compared with the average variances extraction (AVE) and no violation of construct validity is found (Fornell and Larcker, 1981) (Table 8 for Australian samples; Table 9 for Taiwanese samples). The results show both convergent and discriminant validity are satisfied for two sample populations.
The composite reliability of each construct is also found over 0.70 acceptable criterions in both samples (Hair et al., 2006) (Table 10).

Hypothesis testing

Due to the binary data from user responses, logistic regression is preferable to identify a group of users and non-users. This technique was also applied in a number of exploratory studies of technology adoption (Carlsson et al., 2005; Chau and Tam, 1997; Dwivedi et al., 2006; Shin, 2007). One advantages of logistic regression is the ability to assess the effects of both metric and non-metric variables in the model. Unlike multiple regressions, logistic regression utilises a different algorithm (that is, maximum likelihood) to estimate all of the indicators in a linear correlation with dichotomous responses (that is 0 and 1). Therefore, predictive accuracy from odds ratio (that is, Wald statistics) and group classification (that is, predicted percentage) provides additional information to compare the effects of independent variables on two groups of respondents. While similar to multiple regressions, the research model can also be assessed through a number of criteria such as model fit (χ^2), explain probability (R^2), significant coefficient (B), variable relationship (Exp(B)) and classification accuracy (%) (Table 11 for Australian samples; Table 12 for Taiwanese samples).

From the contingency tables, the criteria for model fit ($p<0.05$), explain probability (variance > 3%) and classification accuracy (better than random choice 50% or above) are acceptable in both samples. Only the commerce model (that is the use of mobile phones for commercial transactions) in Taiwanese samples has a poor model fit (Log likelihood $\chi^2=0.136>0.05$ and Hosmer-Lemeshow $\chi^2=0.043<0.05$). The variance explained in Australian samples is ranged from 29% to 52.6% compared to the range from 13.8% to 24.7% in Taiwanese samples. Hence, the four different models in Australian samples explain better variance than in Taiwanese samples.

Worth noting, due to the prediction of linear relationship between zero and 1 in logistic regression analysis, the stepwise method (that is, backward stepwise) is chosen to identify the relevancy of factors in the model testing (Menard, 2002). The significant factors in four different models are illustrated based on the Wald statistics and ρ-value as follows. As suggested by Menard (2002), the p-value from 0.15 to 0.25 for identifying the significant factors in logistic regression analysis is acceptable. Considering the effect size (sample size less than 250) and the avoidance of type II error, the criterion of statistical significance for each variable is set at 0.1 instead of 0.05.

The use of mobile phone for PIM

In Australian samples, PU is the most significant factor that predicts the use of mobile phone for PIM (Wald=8.363, $p<0.005$). Same result is also obtained in Taiwanese samples (Wald=10.338, $p<0.005$). Gender appears to be an important factor that moderates PU and PE in Australian samples (PE* gender, Wald=4.395, $p<0.05$). However, in Taiwanese samples, the selection of phone type is the important moderator that influences both PU and PE (PE*phone type, Wald=7.777, $p<.005$). In contrast, the selection of phone type only has a moderate influence on PE in Australian samples (Wald=5.107, $p<0.05$).

The use of mobile phone for entertainment

PE is shown as a critical factor in determining the use of mobile phones for entertainment in both Australian and Taiwanese samples. The selection of phone types significantly moderates the individual perceptions of usefulness in Taiwanese samples (Wald=8.243, $p<0.005$) while the selection of phone type on the other hand influences PE in Australian samples (Wald=14.988,

Table 7. The ratio between user and non-user in the convergent use of mobile phones between Australian and Taiwan.

Model	PIM		Entertainment		E-mail		Commerce	
(%)	**AU**	**TW**	**AU**	**TW**	**AU**	**TW**	**AU**	**TW**
User	20.7	23.5	39	22.3	69.9	76.10	87.4	88.8
Non-user	79.3	76.5	61	77.7	30.1	23.90	12.6	11.2

Note: AU (Australia); TW (Taiwan).

Table 8. AVE and correlation between variables in Australian samples.

	PU	PRISK	PE-PIM	PE-ENT	PE-EMAIL	PE-COMM
PU	**0.54**					
PRISK	-0.283	**0.72**				
PE-PIM	0.257	-0.136	**0.69**			
PE-ENT	0.375	-0.171	0.586	**0.82**		
PE-EMAIL	0.244	-0.336	0.489	0.431	**0.82**	
PE-COMM	0.146	-0.383	0.386	0.392	0.672	**0.82**

Note 1. PU: perceived usefulness; PRISK: perceived risk; PE: perceived enjoyment
Note 2: AVE is listed in bold.

Table 9. AVE and correlation between variables in Taiwanese samples.

	PU	PRISK	PE-PIM	PE-ENT	PE-EMAIL	PE-COMM
PU	**0.49**					
PRISK	-0.050	**0.77**				
PE-PIM	0.226	0.144	**0.77**			
PE-ENT	0.300	0.033	0.637	**0.86**		
PE-EMAIL	0.152	-0.025	0.426	0.392	**0.80**	
PE-COMM	0.063	-0.280	0.286	0.080	0.379	**0.85**

Note 1: PU: perceived usefulness; PRISK: perceived risk; PE: perceived enjoyment
Note 2: AVE is listed in bold.

Table 10. Composite reliability of research indicators.

	PU	PRISK	PE-PIM	PE-ENT	PE-EMAIL	PE-COMM
Australian	0.79	0.75	0.82	0.90	0.86	0.85
Taiwanese	0.80	0.84	0.87	0.91	0.87	0.90

PU: perceived usefulness; PRISK: perceived risk; PE: perceived enjoyment.

p<0.005). Meanwhile, the respondents' age and gender also appear to have significant influence on PE. Ownership of other devices, such as mp3 players, game consoles and personal computers, also has a major impact on PU in Australian samples (Wald=14.225, p<0.005).

The use of mobile phone for e-mail communication

From the use of mobile phones for sending and receiving e-mail, none of direct indicator, such as PU and PE, is shown significant in both samples. Instead, gender is shown as an important factor that influences both PU and PE in Australian samples. The selection of phone type and the ownership of other devices have influences on PE and PU respectively (p<0.01). In contrast, service plan is a critical factor in Taiwanese samples which moderates both PU (Wald=5.456, p<0.05) and PE (Wald=10.236, p<0.005). Similar to the findings in Australian samples, phone type selection and ownership of other digital devices have similar impact on PE and PU in both samples.

The use of mobile phone for commercial transactions

Oriented from the domain of e-commerce, the construct of perceived risk is a sole indicator that directly predicts the use of mobile phones for online transactions in Australian samples (Wald=10.364, p<0.005). However, this factor has a weak effect

Table 11. Logistic regression results in the Australian samples.

Variable	PIM		Entertainment		E-mail		Commerce	
	Wald (Sig)	Odds ratio	Wald (Sig)	Odds ratio	Wald (Sig)	Odds ratio	Wald (Sig)	Odds ratio
PU (H_1)	.938	1.633	.144	.786	.017	.930	1.757	.274
PE(H_2)	.143	1.212	1.925	2.430	.747	1.216	1.276	6.575
PRISK((H_3)	N/A	N/A	N/A	N/A	N/A	N/A	10.569***	.551
Age * PU(H_{4-1})	.000	1.006	1.161	1.598	.106	1.130	1.905	3.325
Age * PE(H_{4-2})	.189	.878	3.243	.427	.182	.844	2.113	.095
Gender * PU(H_{5-1})	.888	.754	.120	1.119	3.328	.635	3.331	.524
Gender * PE(H_{5-2})	1.452	1.392	.168	1.122	4.844*	1.808	3.590	2.314
Phone Type * PU (H_{6-1})	.037	.964	.400	.896	.003	1.009	.030	.968
Phone Type * PE(H_{6-2})	.580	1.159	3.011	1.341	.351	1.108	.124	1.081
Service Plan * PU(H_{7-1})	N/A	N/A	N/A	N/A	1.076	1.104	.809	1.103
Service Plan * PE(H_{7-2})	N/A	N/A	N/A	N/A	1.118	.899	.151	.953
Other Devices * PU(H_8)	2.232	1.042	6.760**	1.066	6.374*	1.055	8.202***	1.088
-2 Log likelihood	171.242		183.550		206.687		110.060	
Log likelihood χ^2 (p-value)	44.118 (.000)		107.788 (.000)		54.852 (.000)		47.460 (.000)	
Nagelkerke R Square	0.290		0.526		0327		0.400	
Hosmer-Lemeshow χ^2 (p-value)	5.876 (.661)		9.563 (.297)		6.634(.577)		5.541 (.699)	
Predictive percentage	85.1%		84.2%		76.4%		84.7%	

Note: PU (perceived usefulness); PE (perceived enjoyment); PRISK (perceived risk).
***p<.005; **p<0.01; * p<0.05.

in Taiwanese samples (Wald=0.102, p=0.749). When comparing the significant moderators in both samples, gender has a significant impact on both PU and PE in Australian samples, while age has moderate effects on PU and PE in Taiwanese samples. Moreover, the selection of phone type also has a moderate effect on PU and PE in Taiwanese samples (Phone type * PE, Wald=5.563, p<0.05). It is very different than the findings in Australian as the subscription of service plan moderates the perceptions of usefulness (Wald=2.945, p<0.1).

From the findings between Australian and Taiwanese samples in Table 13 and Table 14 the effects of direct indicators such as usefulness, enjoyment, and risk, are found that effectively predict the use of mobile phones for specific purposes accordingly, namely personal information management (PIM), entertainment, and commercial transactions. The moderating effects, such as age, gender, phone type, service plan, and ownership of other devices have diverse influences on both usefulness and enjoyment based on the different mobile phone uses. It also shows the patterns of user behaviour from the use of mobile phone are heterogeneous based upon the versatile purposes and use contexts in both countries. However, only a few research in IT/IS have taken the different moderator into account (Venkatesh et al., 2003). In this research, these different moderators are found that significantly improve the prediction of different uses of mobile phones compared to 30% to 40% in TAM research (Legris et al., 2003).

RESEARCH FINDINGS

From the cross-comparison between the samples in two different locations, we found some overlapped and different patterns in different mobile phone uses. The factors, such as usefulness and enjoyment, explain the use of mobile phones for PIM and entertainment accordingly. Perceived risk, on the other hand, is perceived as important factor in the use of mobile phones for online transaction in Australian samples, but not significant in Taiwanese samples. Users' age, gender, phone type, service plan, and device ownership have different impacts on the use of mobile phones across different models from two countries.

Exclusive from the construct of culture in prior studies, we found consumers from different countries considered feeling fun, interesting, and

Table 12. Logistic regression results in the Taiwanese samples.

Variable	PIM		Entertainment		E-mail		Commerce	
	Wald (Sig)	Odds ratio	Wald (Sig)	Odds ratio	Wald (Sig)	Odds ratio	Wald (Sig)	Odds ratio
PU (H_1)	2.038	80.662	0.066	0.876	0.064	1.327	0.139	1.727
PE(H_2)	1.253	0.023	1.660	1.979	0.031	0.825	0.105	0.568
PRISK((H_3)	N/A	N/A	N/A	N/A	N/A	N/A	0.102	0.937
Age * PU(H_{4-1})	2.161	0.688	1.674	1.333	0.285	1.127	2.348	1.501
Age * PE(H_{4-2})	3.215	1.555	0.544	0.863	1.523	0.754	4.057*	0.516
Gender * PU(H_{5-1})	N/A	N/A	N/A	N/A	4.535*	0.771	0.204	0.918
Gender * PE(H_{5-2})	N/A	N/A	N/A	N/A	5.984*	1.380	0.430	1.186
Phone Type * PU (H_{6-1})	1.164	0.040	0.004	1.027	0.137	1.477	0.651	0.334
Phone Type * PE(H_{6-2})	1.048	30.067	0.198	0.820	0.008	0.911	0.884	4.413
Service Plan * PU(H_{7-1})	1.147	1.326	0.092	1.080	0.352	0.873	0.190	1.123
Service Plan * PE(H_{7-2})	0.287	0.870	0.012	1.025	1.276	1.309	0.003	1.019
Other Devices * PU(H_8)	0.410	0.984	0.566	0.982	7.444**	1.064	1.905	1.044
-2 Log likelihood	177.977		193.513		196.390		107.574	
Log likelihood χ^2 (p-value)	31.188 (.000)		19.399 (.022)		36.449 (.000)		17.387 (.136)	
Nagelkerke R Square	0.222		0.138		0.247		0.189	
Hosmer-Lemeshow χ^2 (p-value)	5.539 (.699)		10.637 (.223)		7.881 (.445)		15.939 (.043)	
Predictive percentage	80.2%		80.5%		77.5%		86.4%	

Note: PU (perceived usefulness); PE (perceived enjoyment); PRISK (perceived risk).
***p<0.005; **p<0.01; * p<0.05.

exciting as the most important drivers to use mobile phones for a variety of purposes, especially for entertainment. Considering the similarity of undergraduate students in both samples, the results can be only generalised to conclude that young students who are inclined to be fun-seekers when considering using mobile phones as a medium for enjoying entertainment content, sharing communication and activities with friends. This scenario is supported by Wolf (1999) as he considered the social impact of new media may change people's life style into a series of fun-orientated behaviours. The values of wireless capacity and mobility may further facilitate young people' attitude and intention to invoke more activities from hedonic orientation which are also reflects to their choices of phone type and service plan.

However, the majority of these studies have been conducted in North America and few studies have been conducted based on a cross-cultural context. Yet the applicability of the findings in other cultures is unknown. In recent study, within the same geographical region, Zhang (2010) found culture differences still exist in the use of mobile phones. According to Hofstede (1982) a theory that applies in one culture does not necessary apply in other cultures. Therefore the adoption of mobile technology should also examine the influences of cultural differences.

Several authors have found differences in their studies of technology adoption in different cultural contexts (Igbaria and Zviran, 1996; Scott et al., 2007; Straub, 1994). However few researches, such as Lee et al. (2007), Mao (2005), Harris et al. (2005) and Kim et al. (2004), has been done in the adoption of mobile technology based on cultural differences. The research found that the Taiwanese sample presents a strong interaction between the perceived usefulness and the service plan with regard to email communication. While the Australian sample presents a strong interaction between perceived usefulness and service plan in the use for online transactions. In this regard, we found the choices of device type and

Table 13. Key indicators of the four models in Australian samples.

PIM		Entertainment		E-mail		Commerce	
Indicator	**Wald**	**Indicator**	**Wald**	**Indicator**	**Wald**	**Indicator**	**Wald**
PU	8.363***	PE	6.682*	PE*Phone type	6.573**	PRISK	10.364***
PE*Phone type	5.107*	PE*Phone type	14.988***	Gender * PU	2.836	Service plan*PU	2.945
Gender * PU	3.094	Age* PE	11.403***	Gender * PE	6.139*	Age * PE	3.146
Gender * PE	4.395*	Gender* PE	8.452***	Other devices* PU	9.968***	Gender * PU	7.880***
		Other devices*PU	14.225***			Gender * PE	10.338***
						Other devices*PU	9.652***

Table 14. Key indicators in Taiwanese samples.

PIM		Entertainment		E-mail		Commerce	
Indicator	**Wald**	**Indicator**	**Wald**	**Indicator**	**Wald**	**Indicator**	**Wald**
PU	10.338***	PE	2.895	PE * Phone type	6.309*	PU * Phone type	3.788
PU*Phone type	2.951	PU*Phone type	8.243***	PU * Service plan	5.456*	PE * Phone type	5.563*
PE*Phone type	7.777***			PE * Service plan	10.236***	Age * PU	4.635*
Age * PU	2.975			Age * PU	6.933**	Age * PE	7.115**
				Gender * PE	3.299	Other devices*PU	4.286*
				Other devices*PU	7.260**		

Note: * p< 0.05; ** p< 0.01; *** p<0.005.

the subscription of service plan have different impact on both usefulness and enjoyment in both samples. In fact, as noted, both device type and service plan indirectly determines individuals' capabilities (for example. more talking minutes, service cost, and data capacity) and their perceptions of usefulness or enjoyable from the underlying uses if they have subscribed to a certain level of service plan or choose a particular mobile handset in use. This is partly consistent with the findings by Teerling et al. (2009). They showed a strong relationship between bundle services and perceived value. In addition, the Taiwanese sample presents a lower perceived risk in relation to the adoption of mobiles services, while the Australian sample presents a higher perceived risk. This may be influence by the level of user experience on using mobiles phones in both samples. Teerling et al. (2009) also found that adopters may perceive stronger value from bundling and perceived less risk.

Meanwhile, the non-adopters may prefer to use separate products as a result of uncertainty. Therefore, the Taiwanese respondents could be more experienced with the use of mobile phones for online transactions, as they may perceive less risk when using online transactions as their usage is mostly charged by monthly bills. Hence, the selection of phone type (for example, 3G compatible) is more important than the subscription of service plan when it comes to the online transactions via mobile phones. While the Australian sample may have less experienced and could place more importance on the level of risk and the subscription of service plan (for example, prepaid voice versus 3G data plan).

This study also found that regarding to the Taiwanese sample, gender does not show significant impact on the different dimensions analysed. This may be due to the age of the participants, which are university students from generation Y. This is consistent with the conclusions of Morris et al. (2005). In their study of employee decisions about new technology, they found that the technology acceptance is higher in younger

workers and the image of a male-oriented domain in the adoption of technological products may be disappearing. From the study of mobile phone uses by teenagers, Wilska (2003) also found males and females have equal perceptions and consumption style once they are familiar with the use of technology. In contrast, the age of Australian samples is older, thus the effects of age and gender may still affect the individual perceptions and behaviours.

Another relevant relationship that emerges from this research is the influence of entertainment in the phone type and service plan selected by the Taiwanese sample. This could be explained by the collectivistic characteristic of the Taiwanese sample. According to Hofstede (1982) the Eastern countries score high in collectivism, meaning that this culture gives importance to the closeness of the relationship between persons and the groups' opinion is very relevant. Therefore, the influence of phone type in the Taiwanese sample may be due to a common practice among young people that is to play games and send e-mail through their mobiles phones and share the joys with their peers. Thus, the type of phone and service plan should be compatible with their friends, in order to be able to perform such group activities.

Limitation

Despite the efforts devoted throughout the research to minimize potential limitations, there are certain limitations with this study. Firstly, due to the choice of sample frame, the research findings were focused on university students. Student samples, classified as a group of non-workers, may reveal behavior patterns that are distinct from those of working groups situated in a mandatory environment (Venkatesh et al., 2003). The use of student samples was also criticized as one of the methodological drawbacks in TAM research (Lee et al., 2003).The effects of respondents' education and occupation tended to be homogeneous as they were all university students. However, university students are characterized as potential adopters in the use of converged devices in the literature and market reports. Hence, the use of university students as studying samples should be more accurately reflected to the target population than general mobile users (Dillman, 2007). Future research might benefit from comparing the conceptual models across different user groups, such as organizational workers, home users, and telecommuters.

Secondly, this research contained a sample size around 250 cases and achieved a minimum sample size for statistical analysis (for example, logistic), but it was not possible to cross-validate the causal relationships between research indicators and outcome behaviors by splitting the samples. It is anticipated to increase the test-retest validity if future research is conducted with a larger sample.

Lastly, due to the design of this research project, the effect and interaction between research indicators and user behaviors could not be observed using a longitudinal approach. In other words, the impact of convergent technologies on the use of mobile phones could be more explicitly specified if future researchers were to conduct longitudinal studies to observe the incremental changes in the use of mobile phones. Moreover, instead of explanning the monological relationship between individual intention and system usage in a linear regression, this research analyzed the relationship by taking into account the direct and interaction factors that explain the non-linear relationship between different perceptions and behaviors. However, as the behavioral measures were categorized as dichotomous data (for example. use or not use) and tested separately in different models. Those independent and dependent variables were unable to further analyze their interrelationships but to analyze them with a higher order of behavior, which is the convergence model. In addition, future research could consider verifying the empirical models by expanding the measures or analytical techniques of usage behaviors, such as using self-report usage, or using other analytical techniques such as Structural Equation Modeling (SEM) to test the variance-covariance structure in a single framework.

DISCUSSION

The contribution of research implication is sound not only in business practices but also opens a new door for future research to explore the proliferation of advanced mobile devices and services, and user behaviours from a mobile platform.

From the results of factorial structure and monological relationship between usability and technology adoption, it is easy to understand why the measurements of usefulness and ease of use have the limitation to explain the full capacity of actual user behaviours. A number of researchers also recommended for future research to incorporate more constructs from specific domains, such as the exploration of other psychological measures (Agarwal and Karahanna, 2000; Webster and Martocchio, 1992), to research on specific contexts (Chau and Hu, 2002; Cheung et al., 2000), or the inclusion of task consideration (Sun and Zhang, 2005). The findings of this study further expand the incumbent effects of perceived usefulness and ease of use from the instrumental use into the different uses for four versatile purposes. For example, the use contexts of mobile phones are expanded from the enrichment of both research indicators (that is, usefulness, enjoyment and risk) and purpose of use (that is, PIM, entertainment, e-mail communication and commercial transactions). By doing so, we believe the explanation of conceptual models are improved to specify the heterogeneous patterns and use

purposes among mobile phone users.

From the salient validation, the models used to predict the multiple use of mobile phone in Australian samples have a better performance than the same models applied in Taiwanese samples. This may imply that more critical factors that are yet to explore that influence the mobile phone users in Taiwan. Considering the proliferation of mobile technologies and infrastructure in some Asian countries, such as Japan, Korea, Hong Kong and Taiwan, the technology environment, the user experience, social network, and cultural influences are more complex than the scenarios in Australia. More research is anticipated to explain the differences of technology use between Asian and Western countries.

For marketing advanced mobile data services (MDS) in Australia, we believe the unbundled phone type and service plan may decrease the opportunity of "trialability" (Rogers and Shoemaker, 1971) to potential users and further constrain the individuals' capabilities from multiple uses. Therefore, major telecommunication providers, such as Telstra and Optus, should change their strategy on voice prepaid and lower the barrier on cap plan and expect for more trials on new data services.

Based on the implications of indirect effects, business providers should also pay more attention to the potential influences from users' demographics, prior experiences and ownership with other technologies, the combination of social network and entertainment sharing which might be the most prospective market segment for developing mobile commerce in Taiwan and Australia.

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