

Consumers' Perception of Mobile Internet in Australia

Abstract

Mobile Internet, which refers to the use of the Internet via a handheld device (such as mobile phone or PDA), has received much attention in various countries. At this stage, little is known why this technology has been used widely in some countries such as Japan and Korea, and has not been so in other countries. To enrich the existing studies in this context, which are currently limited, this paper explores the Australian consumer's perception of mobile Internet in order to identify some factors that may foster or hinder its use. The Technology Acceptance Model (TAM) is employed to provide the theoretical foundation for this study. Based on the empirical data collected from a survey, the findings demonstrate the importance of functionality (usefulness), an easy-to-use interface, and social networks as critical influences on both intention to use and the extent of usage of mobile Internet in Australia.

1. Introduction

Mobile Internet has received much attention particularly as an infrastructure for the next wave of electronic commerce, that is, mobile commerce. However, the growth of mobile commerce, including mobile Internet is much slower than predicted (Urbaczewski et al., 2003). Mobile Internet is defined as “wireless access to the digitized contents of the Internet via mobile devices” (Chae and Kim, 2003). These devices include mobile phones, PDAs (personal digital assistants) and laptop computers. Internet access for these devices is currently available via a number of different types of infrastructure including mobile phone networks (2G, 2.5G or 3G)¹, Wi-Fi (as often available in so-called ‘hotspots’) and Wi-Max (as provided in Sydney since March 2004 by Personal Broadband Australia, PBA). However, the latter two are still very limited in usage.

Mobile Internet access through mobile phones is in its infancy. However, its usage is increasing and substantial in some countries. For example, in 2002, 45% of Korean mobile phone subscribers were also mobile Internet subscribers, while in Japan, the subscription rate was a staggering 81% of mobile phone users (Minges, 2003). For high-speed Internet access (over 2.5G or 3G), as a proportion of mobile Internet subscribers, the subscription rate is 6.6% in Japan and 51.1% in Korea (Minges, 2003). In contrast, Australia’s mobile Internet subscription rate in 2002 was only 4.8%. Of these subscribers, only 0.3% used high-speed mobile Internet access. A puzzling aspect of these statistics is that the level of penetration of mobile phone technology in Australia² is actually higher than that of Japan and Korea. Unfortunately, at present, there is little research on why mobile Internet usage is so low in Australia.

The aim of this study is therefore to assess consumers’ perceptions of the usefulness and the relevance of mobile Internet in Australia through a survey study. The Technology Acceptance Model (TAM), which has been widely used in technology adoption studies, is employed to provide the theoretical foundation for this study. Our questionnaire items were developed based on the existing, well-established questionnaire used in the TAM literature, with some minor modifications to suit this particular case.

The findings demonstrate the applicability of the Technology Acceptance Model in assessing the acceptance of mobile Internet in Australia. Consistent with many previous studies, the perceived usefulness and perceived ease of use of mobile Internet technology were found to have positive impacts on the attitude towards using the technology. Attitude, in turn, strongly influences the behavioral intention to use mobile Internet. Finally, the behavioral intention to use mobile Internet affects the extent of actual usage. In addition to the factors suggested by the TAM, this study also shows that social influence has a strong positive impact on the attitude towards using mobile Internet. The understanding of consumers’ perception and expectations of mobile Internet services obtained from this study will be valuable in shaping the future of mobile Internet in Australia.

In the next section, the development of the conceptual model of the acceptance of mobile Internet is discussed. We then describe the survey research method employed in this study,

¹ Whether mobile Internet is accessed over 2G, 2.5G or 3G can mean a completely different experience to users in terms of service quality and application availability. In that they are initially designed and targeted to support mobile phones, we group them together.

² The data is not consistent. In Minges (2003), mobile phone subscribers per 100 inhabitants are 68 in Australia and Korea and 58 in Japan.

the data validation and analysis process used, and the findings. We conclude the paper by acknowledging a number of limitations of our study and discussing the implications of our findings for mobile Internet service providers, the research models tested, and for future research.

2. The Research Model

Study of factors affecting the adoption of various technological innovations has attracted the attention of researchers and practitioners for many years (Pfeffer, 1982; Chaffe, 1985; King, 1990; Keil, 1991; Slappendel, 1996). Various frameworks and models have been developed to explore determinants of technology acceptance and adoption, including the Diffusion of Innovations model (Rogers, 1983), theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1975), theory of Planned Behavior (TPB) (Ajzen, 1985), the Technology Acceptance Model (TAM) (Davis, 1989) and various extended models of the TAM (Davis et al., 1989; Dishaw and Strong, 1999; Davis and Venkatesh, 2000). Among the many adoption models, the TAM has been claimed to be the most influential and widely adopted to predict the acceptance and use of various technologies due to its strength in theoretical basis and empirical support (Saga and Zmud, 1994). Therefore, this study has adopted the TAM with minor modifications to assess the acceptance of mobile Internet in Australia.

Figure 1 depicts the research model for the acceptance of mobile Internet used in this study. The model was mainly derived from the TAM, with three additional constructs, namely ‘Visibility’ and ‘Perceived Cost’ (derived from Everett Rogers’ Diffusion of Innovations theory), ‘Social Influence’ (derived from the Theory of Reasoned Action). It must be emphasized that we are measuring perceived cost rather than the amount spent, on the basis that logically, attitudes are most likely to be determined by the level of affordability rather than the market price. These three constructs are shown in italics in Figure 1. Nine relationships between the constructs in Figure 1 are hypothesized, and are discussed below.

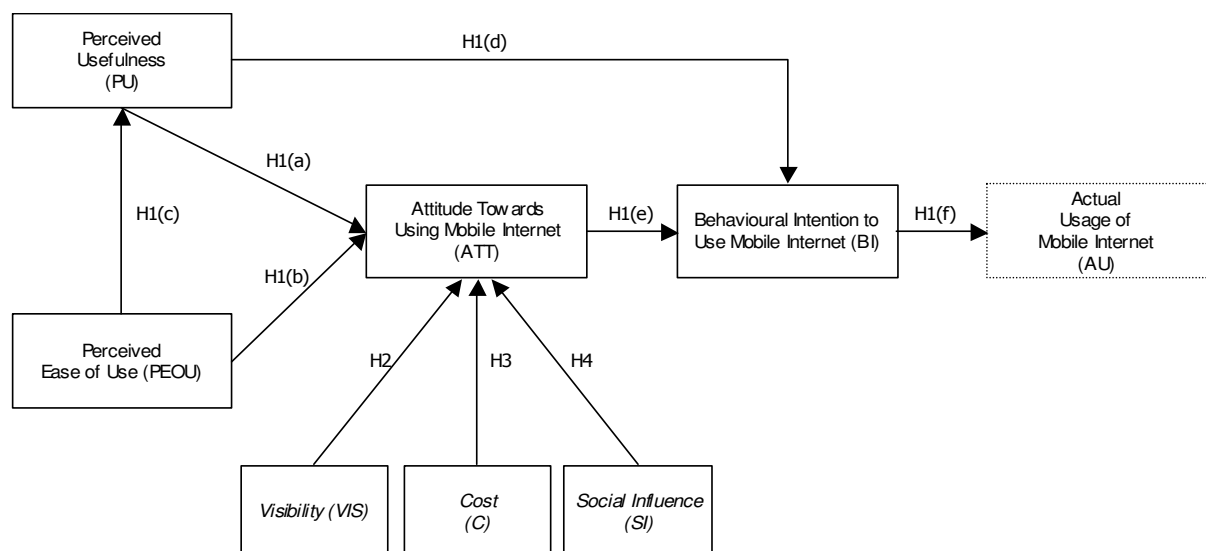


Figure 1. The Acceptance Model of Mobile Internet

Six hypotheses — H1(a) to H1(f) in Figure 1 — originated from the TAM. The TAM was developed by Davis (1989) based on the Theory of Reasoned Action (TRA) (Ajzen and

Fishbein, 1975) to explain computer usage behavior. The goal of the TAM is “to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified” (Davis, 1989, p.985). It proposes that ‘Perceived Usefulness’ (PU) and ‘Perceived Ease of Use’ (PEOU) largely determine whether or not a technological innovation will be used. PU is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” while PEOU refers to “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989, p.320). Based on this, we constructed the following hypotheses in relation to mobile Internet acceptance:

H1 (a): There is a positive relationship between Perceived Usefulness and Attitude towards using mobile Internet.

H1 (b): There is a positive relationship between Perceived Ease of Use and Attitude towards using mobile Internet.

In addition, the improved technology acceptance model (Davis, 1993) proposes that Perceived Usefulness is influenced by Perceived Ease of Use, but not vice versa: Improving the usability of technology should enhance its value, but it must first be useful — no amount of engineering to make a technology easier to use will add value if the technology is not useful to begin with. This relationship has been confirmed in a number of other studies (see for examples, Davis et al., 1989; Davis, 1993; Taylor and Todd, 1995; Chau, 1996). Therefore, we hypothesized that if consumers found mobile Internet easy to use, then they would also find it useful.

H1 (c): There is a positive relationship between Perceived Ease of Use and Perceived Usefulness of mobile Internet.

The TAM further postulates that behavioral intention (BI) to use a particular technology is determined by attitude and perceived usefulness. Past studies invariably show that the latter factor has a large impact on intention, either directly, or indirectly via attitude (sometimes via both paths). The size of the total effect (usually shown as γ or r^2) generally exceeds 0.20. The level of behavioral intention, in turn, determines the likelihood that actual usage (AU) will occur (Ajzen and Fishbein, 1975; Davis et al., 1989). These relationships were examined in the context of mobile Internet using the following hypotheses:

H1 (d): There is a positive relationship between Perceived Usefulness and Behavioral Intention to use mobile Internet.

H1 (e): There is a positive relationship between Attitude towards using and Behavioral Intention to use mobile Internet.

H1 (f): There is a positive relationship between Behavioral Intention to use and Actual Usage of mobile Internet.

Besides the constructs proposed by the TAM, three additional constructs are included in our model. Firstly, visibility, which refers to the degree to which an innovation is apparent to the potential adopters (Rogers, 1983), affects attitudes towards adopting the innovation. Secondly, the perceived cost (affordability) of the innovation, including the initial and ongoing costs affects the attitude of potential adopters. The following two hypotheses were therefore formulated:

H2: There is a positive relationship between Visibility of the use of mobile Internet and Attitude towards using it.

H3: There is a negative relationship between the cost of using mobile Internet and Attitude towards using it.

Finally, according to the Theory of Reasoned Action (Ajzen and Fishbein, 1975), a person's behavioral intention (BI) is also affected by subjective norms (SN). Subjective norm — the social pressure exerted on the person to perform the behavior — is then affected by normative beliefs and motivations to comply (Ajzen, 1985). Thus, a person may choose a particular behavior although s/he is not favorable towards the behavior and its consequences, if s/he thinks that one or more references believe s/he should behave in such a manner and there are sufficient motivations to comply. The effect of subjective norm on behavioral intention is also in accordance with the extended TAM proposed by Davis et al. (1989).

In this study the effect of the subjective norm was assessed in a construct named 'Social Influence (SI)' (see Figure 1). We reasoned that if supervisors/seniors, co-workers, or relatives believe that mobile Internet is useful, then a person might agree and accept their belief and in turn establish an intention to use it. However, because mobile Internet is still in the early stage of adoption in Australia, we hypothesized that social influence would positively influence the attitude (instead of the intention to use), which would then affect the intention to use. This would allow us to observe whether the existence of social influence would affect a person's decision to use mobile Internet.

H4: There is a positive relationship between Social Influence and the Attitude towards using mobile Internet.

In summary, the model shown in Figure 1 hypothesizes that perceptions of usefulness, ease of use, and cost as well as the visibility of a technology and the influence of ones social network (social influence) all jointly determine attitudes towards that technology. Attitude influences intention to use, which itself determines whether or not the technology is used.

3. Research Design

To test these hypotheses, we administered a survey of consumers' perceptions of mobile Internet in Australia. An online questionnaire was developed to collect the required data in the most efficient manner possible (Batinic, 1997). This questionnaire was then distributed via electronic mail to potential participants. The population of interest was any existing or potential user of mobile Internet in Australia. Participants were identified via University internal mailing lists, as well as list of professionals in industry. To reach as many potential participants as possible, a type of "snowball" sampling technique was also employed, in that each message included additional clause "*please forward this email to any one you think might be interested in this study*" in the invitation email.

To recruit people, an initial invitation letter describing the project and seeking participation was e-mailed to all potential participants. Potential participants expressed their agreement to participate by replying to the invitation e-mail. An e-mail detailing the URL of the questionnaire was then sent out to each person. A department store voucher — given to a randomly chosen participant at the end of the survey — was offered as an incentive to encourage participation. As a result, a total of 212 responses were obtained.

To enhance the validity and reliability of the questionnaire, each statement was phrased in the simplest possible way, and negative (reverse-coded) statements were not used. Pilot testing was conducted with five individuals: three academics, one researcher and one IT consultant. Following the pilot test, the definition of mobile Internet was refined, ambiguous statements were identified and improved, and potentially important measures that had been overlooked were included in the final questionnaire.

The questionnaire items for this study were developed based on various sources (see for example, Davis, 1989; Rhee and Riggins, 1997; Hu et al., 1999; Malhotra and Galletta, 1999; Tan and Teo, 2000; Wu and Lin, 2000), since it is practical to use existing, well-developed questionnaires that have been tested for their validity and reliability (Lucas, 1991). Table 1 summarizes the questionnaire items for each construct of this study. Some information on the costs of using mobile Internet services in Australia was provided to the participants. For each item, the survey respondents were requested to indicate whether they agree or disagree based on a five-point scale: from ‘strongly disagree’ to ‘strongly agree’.

Perceived Usefulness
1. Using mobile Internet can improve my efficiency in my daily work.
2. Using mobile Internet can save me a lot of time in general.
3. Using mobile Internet can enhance my effectiveness in carrying out my daily work.
4. Using mobile Internet enables me to do my work conveniently.
5. Using mobile Internet can increase my productivity.
Perceived Ease of Use
1. Mobile Internet is/might be easy to use.
2. It is/might be easy to become skillful at using mobile Internet.
3. Mobile Internet is /might be user friendly
Attitudes Towards Using Mobile Internet
1.Using mobile Internet is/might be a good idea.
2. Using mobile Internet is/might be a pleasant experience.
3. Using mobile Internet is/might be beneficial to me.
Behavioral Intention to use Mobile Internet
1. I intend to use mobile Internet when the service becomes widely available.
2. Whenever possible, I intend to use mobile Internet.
3. I intend to use mobile Internet if it is inexpensive.
4. I intend to use mobile Internet regardless of the price.
Visibility
1. I have seen others (from various media) using mobile Internet.
2. In my organization / university, I often see mobile Internet being used.
3. I have seen mobile Internet being used outside my organization / university
4. I often see others using mobile Internet in public.
Social Influence
1. I will use mobile Internet if the service is widely used by people in my community.
2. I will adopt mobile Internet if my supervisors / seniors use it.
3. I will adopt mobile Internet if my friends use it.
4. I will adopt mobile Internet if my family members / relatives use it.
Costs
1. The costs of using Mobile Internet are reasonable
2. Mobile Internet offers value for money.

Table 1. The Questionnaire Items

4. Data Analysis

We analyzed the hypothesized research model depicted in Figure 1 using AMOS 5.0, a powerful structural equation modeling (SEM) tool. Applying standard SEM techniques, our analysis was conducted in two phases. In phase 1 we assessed the adequacy of the measurement model, while in phase 2 we assessed the structural model.

In assessing the measurement model, our aim was to ensure that for each construct, the measures used all captured a similar concept, that these concepts were distinct from each other, and that the specification of both the individual constructs and the overall model was parsimonious. This phase therefore involved estimating reliability coefficients — to determine the composite reliability of each latent construct — as well as the convergent and discriminant validity of the research instrument as a whole. In assessing composite reliability, Fornell (1982) recommends retaining items that load highly on their respective measures. In particular, item loadings of approximately 0.70 are regarded as desirable because at this level, each item explains nearly half of the variance in the unobserved, or latent, construct. As a result of this procedure, we dropped three measures (Social2, i.e. item 2 in social influence, Visible1, and Intend2) on the basis that their loadings indicated a very poor match with the relevant construct. Table 2 summarizes the reliability of each latent construct in the research model.

Construct	Alpha score
Attitude towards use	0.86
Cost	0.85
Intention to use	0.82
Perceived ease of use	0.82
Perceived usefulness	0.88
Social influence	0.88
Visibility	0.83

Table 2: Latent Construct Reliability

Discriminant validity — the extent to which sets of measures capture distinct constructs — was determined by comparing each measure’s correlation with every other measure. Following Fornell et al. (1982), the components of a construct were deemed to have adequate discriminant validity if they correlated more highly with each other than with measures of other constructs. Using this procedure, we eliminated a further two measures that exhibited high correlations with components of other constructs (Usefulness item 3 and Intention item 4). Two measures, *efficiency* (Usefulness item 2) and the binary variable “*I have used mobile Internet technology*”, were eliminated because of multi-collinearity problems. The problem with *efficiency* appears to be that a substantial number of respondents equated it with effectiveness. *Frequency of use* is the only indicator variable for usage due to high levels of correlation between it and all other measures of usage collected: *have ever used* (yes/no), *use mobile phone* (yes/no), and *use other mobile device* (yes/no). The high level of correlation produced unstable results in the SEM estimation procedure, and so given the choice between a categorical variable and a number of binary variables, we decided to use the variable that provided the most reliable information (frequency of use). However, it must be noted that frequency is also not an ideal measure: it is coded on a scale from 0 to 11, with the values

indicating: never used (0), used once (1), used 2-5 times (2), used 6-10 times (6), and used regularly (11).

Measure	Index value
CFI	0.92
NFI	0.85
PCFI	0.78
PNFI	0.72
RMSEA	0.07

Table 3: Fit Indices

Finally, the adequacy of the structural model was assessed using the goodness of fit measures shown in Table 3. The number of criteria by which model fit can be measured means that multiple measures are required to give an indication of the degree of fit. Unfortunately, there is little consensus on which measures should actually be used (Maruyana, 1998; Byrne, 2001). Following Byrne’s recommendations, we report the Comparative Fit Index (CFI), the Normed Fit Index (NFI), the Parsimony-Adjusted CFI and NFI (PCFI and PNFI), and the Root Mean-Squared Error of Approximation (RMSEA). CFI and NFI values higher than 0.90 indicate a potentially good fit between the data and the research model; however there is some evidence that the NFI underestimates fit for small samples, so the CFI is generally regarded as the index of choice (Byrne, 2001). The PCFI and PNFI measures, which take into account the complexity of the model, are less subject to this influence. The values reported for our model, of 0.78 and 0.72, are indicative of a good fit (Byrne, 1994). Finally, the RMSEA is considered to indicate a good fit if the value is below 0.1 and an excellent fit if 0.05 or lower (Hu and Bentler, 1999). We therefore conclude that our model is an adequate representation of the data.

4. The Survey Findings

Our final sample consisted of 192 completed and valid responses. The age of the respondents varied from 18 to 55 years. The occupations reported were undergraduate student (161), postgraduate student (8), researcher (9), professional (14), and retired or unemployed (4). Out of 192, 122 respondents reported that they had mobile Internet enabled device, primarily the mobile phone.

The results of the structural equation modeling analysis are shown in Figure 2 (factor scores and direct effects) and Table 4 (total effects). The diagram shows path coefficients in the form of standardized regression coefficients, as well as the statistical significance of each coefficient.

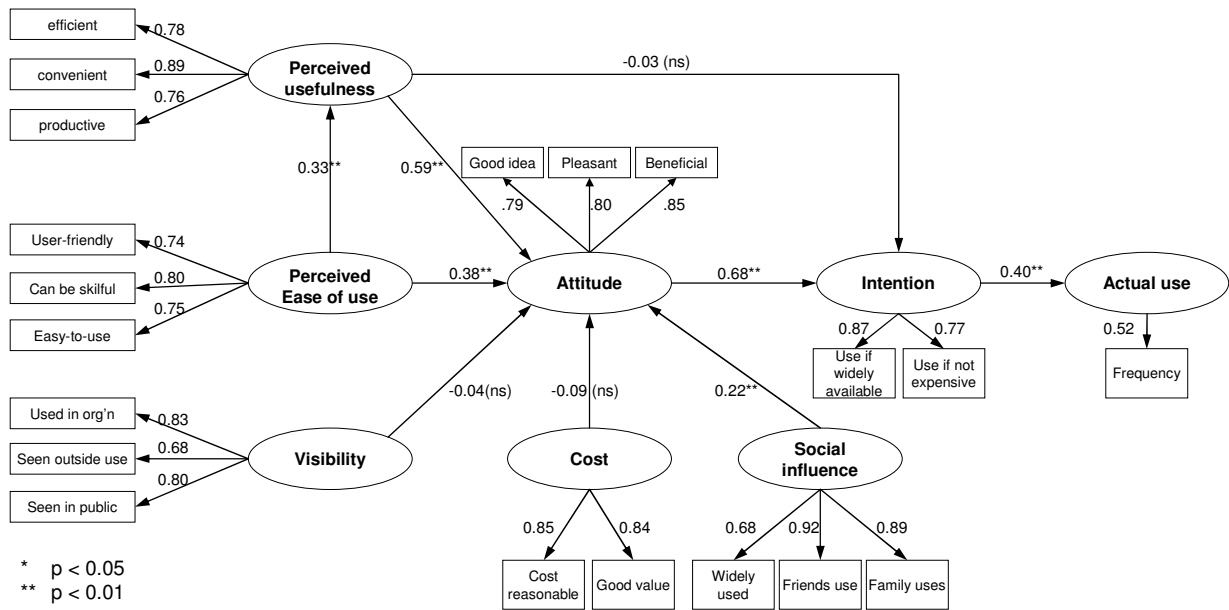


Figure 2: SEM path coefficients

Consistent with hypothesis 1c, perceived ease-of-use has a strong influence on perceived usefulness. The model also supports hypotheses 1a, 1b, and 4 in that perceived usefulness, perceived ease of use, and social influence all have a significant influence on attitude. However, no support was found for the hypothesized relationships between perceived usefulness and intention (H1d), visibility and attitude (H2), and cost and attitude (H3). Given the strong relationship between usefulness and attitude, the lack of support for H1d is at first surprising. However, although the direct effect is not statistically significant, as shown in Table 4, usefulness actually has a substantial indirect effect via attitude ($\gamma = 0.36$).

The relationship between intention and actual usage was also examined. Given the imprecision of the measure of usage, the presence of any relationship is encouraging. That the effect size is not large ($\gamma = 0.40$, $p < 0.01$) is therefore not surprising, and almost certainly understates the actual relationship between intention and frequency of use.

Independent (exogenous) variables	Effect on dependent (endogenous) variables		
	Attitude	Intention	Actual Use
Intention	-	-	.40
Attitude	-	.68	.27
Perceived usefulness	.59	.36	.15
Perceived ease of use	.57	.38	.15
Social influence	.22	.15	.06
Visibility	-	-	-
Cost	-	-	-

Table 4: Standardised total effects

To sum up, tests of the structural model indicate that perceived ease of use and usefulness are the dominant factors affecting attitude, and that all three have a substantial influence on both intention to use and frequency of use. Social networks, particularly the behavior of friends and family members, have a small but significant effect on attitude formation. In contrast, visibility and perceived cost appear to play no role in either attitude formation or usage intentions.

That visibility has no effect is, in hindsight, not surprising, given that it is essentially an invisible service: one cannot easily observe the use of a specific type of communications services. Instead, knowledge of usage is most likely to come from close associates.

We speculate the lack of impact of cost on attitude, particularly given that some participants specifically cited high mobile Internet connection and data communication costs as a problem, is due to the fact that perceived cost is a function of the type of communications contract used by each participant. That is, although cost was clearly an issue for some, if mobile Internet capability is bundled into a mobile phone contract, Internet cost is probably not separable from other communications costs, and so has no influence on attitudes.

6. Discussion and Conclusion

The findings of the study have demonstrated the applicability of the Technology Acceptance Model in assessing the acceptance of mobile Internet in Australia. All of the constructs proposed in the TAM and their relationships, except for the relationship between the perceived usefulness and intention to use mobile technology, were found to be relevant in this study. The perceived usefulness of mobile Internet is influenced directly by the perceived ease of use. In addition, these two constructs do positively affect the attitude towards using mobile Internet and this attitude, in turn, influences the intention and the actual use. The study further shows that the perceived usefulness and the intention to use mobile technology have an indirect relationship via the attitude towards mobile Internet. Furthermore, this study has showed that social influence plays an important role in shaping the attitude of adopters and potential adopters of mobile Internet, as demonstrated in this study. However, costs and visibility of the technology were found not to have an impact on the attitude. Figure 2 presents the revised model of the acceptance of mobile Internet in Australia.

Overall, the results indicate that there is a positive attitude towards using mobile Internet facilities (average response of 3.48 for the three items in this construct). However, a further look at the results of the study indicates that mobile Internet technology still has some way to go in terms of its functionality. Specifically, the majority of the participants perceived this technology as not very useful with the average responses of 2.94 (based on a five-point scale: 1 (strongly disagree) to 5 (strongly agree)), although it was perceived to be reasonably easy to use (average of 3.29). In particular, the participants appear to be unsatisfied with the costs of using mobile Internet services as indicated by the average response of 2.16. A closer look at the survey results shows that a high proportion of the participants have an intention to use mobile Internet if it is inexpensive (average response of 3.99).

All this suggests that there is potential for mobile Internet to flourish in Australia. However, for this to happen, the telecommunication providers must enhance the ease of use and usefulness of mobile Internet services for the users given that these two factors play a critical role in the formation of a positive attitude towards the use of the technology. The strong effect of usefulness confirms the need to develop content and applications which people will find useful, although results also indicate that substantial effort needs to be made to ensure

that content and applications are as easy to use as possible. Finally, although the survey found that costs do not appear to play a significant role in the attitude formation process, the strong impact of social networks suggests that a variety of strategies including cost reduction should be used to attract cost-sensitive opinion leaders who, in turn, will influence the intentions of potential adopters to use mobile Internet.

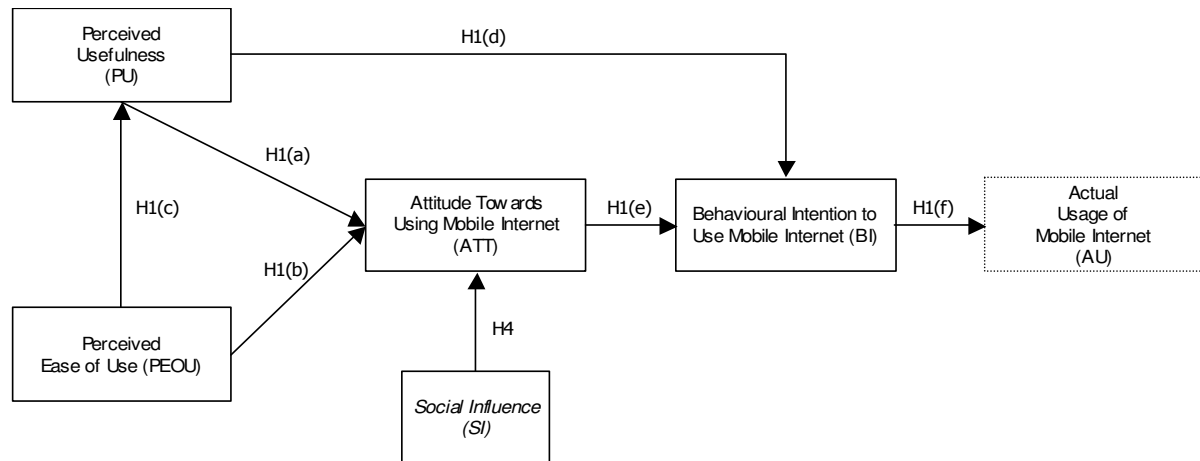


Figure 3: The Revised Model of Mobile Internet Acceptance

One of the limitations of this study is that since the survey respondents were dominated by Victorian respondents and the majority are students, the results of this study may not generalize beyond the sample. However, it is expected that Victorian consumers should not differ significantly from other Australian consumers in general, particularly in terms of their familiarity of the capabilities of mobile Internet technology and their access to the mobile devices with the Internet capability. Furthermore, given that data from the 2001 Australian Census indicates mobile phone users are predominantly young and male ⁽³⁾, we believe that the demographic used in our study is highly representative of mobile Internet users in general.

To complement the findings of this study, future research could be performed to further explore the reasons for the slow uptake of mobile Internet in Australia by assessing customer behavior and market environment. It would also be useful to compare results with other countries in which mobile Internet is used widely in order to further identify some factors that can promote the growth of mobile Internet in Australia.

³ http://www.natsem.canberra.edu.au/pubs/otherpubs/netaccess_barriers/summary.pdf

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