APPLICATION AND DEVICE CHARACTERISTICS AS DRIVERS FOR SMART MOBILE DEVICE ADOPTION AND PRODUCTIVITY

Mustafa Alley[1]
Michael Gardiner

ABSTRACT

This paper proposes an adaptation of the Technology Acceptance Model (TAM) that can be employed to explain and predict the acceptance of SMDs. Also included in the model are a number of external and new moderating variables that can be used to explain user intentions and subsequent usage behaviour. The model holds that Perceived Mobility Value and Perceived Enjoyment are direct determinants of usage intention and behaviour and that Activity-based Usage and Device Characteristics are posited to mediate the impact of these constructs. The proposed model aims to enhance one's understanding of consumer motivations for using SMDs and can aid efforts to promote the adoption and diffusion of these devices.

Keywords: Smart Mobile Devices, TAM, technology adoption, consumer motivation, smart devices

INTRODUCTION

One of the fastest growing fields in information and communications technology over the last few years has been smart mobile technology incorporated in mobile phones, tablets and e-readers (O'Reilly & Duane 2010). Mobile devices have evolved in design and usage, generating new opportunities and enhancing value and productivity (Stewart & Pavlou 2002). Increased processing power, improved accessibility, a multitude of diverse applications and better connection to the Internet and are all proposed as reasons for this increased popularity and evolution (Noll 2006).

These smart devices, which offer advanced computing ability and connectivity, typically combine the functions of a personal digital assistant (PDA), mobile phone, portable media players and camera phones with high-resolution touchscreens, e-book readers, GPS navigation, Wi-Fi and mobile broadband access using third-party and proprietary applications. According to Gartner (2010), in the first quarter of 2010, 17.3 percent of all mobile phones were smartphones, compared to 13.6 percent in 2009. This amounts to an increase of approximately 49 percent in one year. The changing technology and environment has given rise to a number of competing mobile operating systems that support an integrated touchscreen application environment of which the three dominant players in the marketplace are Google (Android), the Apple (IOS) and Microsoft (Windows Phone) (Gartner 2011). The common features that differentiate these platforms from other offerings have been the touch screen interface and the variety and availability of relatively low cost third-party applications. These applications are providing increased functionality, flexibility and scalability.

While these smart mobile devices (SMDs) possess the capacity to assimilate a number of uses in a single platform device for business, education, entertainment and productivity purposes,

[1] Mustafa Ally (mustafa.ally@usq.edu.au) is a Lecturer in the School of Information Systems, Faculty of Business & Law, University of Southern Queensland, Australia; Michael Gardiner (michael.gardiner@usq.edu.au) is a Lecturer in Marketing in the School of Management & Marketing, Faculty of Business, University of Southern Queensland, Australia.

it raises the question as to the extent to which these and other factors affect their adoption and continued usage. The aim of this research is to identify factors or constructs that are likely to impact on the uptake of SMDs, in particular, with regard to their usage and usability with other adoption constructs.

Trends in SMDs

The unique characteristics of these devices, coupled with the challenges outlined above, give rise to investigate these attributes with a view to determining the adoption of SMDs. These, in turn, give rise to a number of related questions. For example, to what extent are consumers willing to embrace the technology given the benefits that have been touted? What barriers/incentives might reduce/increase the adoption and diffusion of SMDS in the consumer market? This study explores the adoption of Smart Mobile Devices and their unique characteristics utilizing existing theories on technology acceptance and analysing user acceptance behaviour. This approach has been used previously in a number of studies on mobile technologies that include mobile wallets, mobile commerce, mobile services and mobile learning (e.g., Carlsson et al. 2006; Pagani 2004; Shin 2009; Wu, Tao & Yang 2007). To this end we commence with a discussion on TAM and its relevance to our study.

Technology Acceptance Model (TAM)

In order to study the effects of usage and usability factors in relation to smart mobile devices, a robust and reliable framework is required. The information technology discipline has been well served by the application of the Technology Acceptance Model (TAM) (Davis 1986, 1989; Venkatesh & Bala 2008; Venkatesh & Davis 2000; Venkatesh et al. 2003); and many empirical studies have tested the TAM model and confirmed its efficacy. However, TAM was initially designed to predict a user's acceptance of information technology and usage on the job. Its use has changed with time, and there is a need to adapt the model for a changing environment. This paper proposes to advance this model.

MODEL DEVELOPMENT

While the TAM model has been the basis of a number of studies on technology adoption, many papers have modified and/or adapted the model for their particular areas of research (Sciencewatch 2009). We argue that the TAM model does not take into account the characteristics inherent in smart mobile devices, and does not provide the level of detail required for analysing the unique and distinguishing attributes of these devices. This paper will propose a number of factors related to SMDs that will advance the TAM and improve its applicability for future research.

Factors identified from literature

A comprehensive review of the literature on TAM and its many derivatives has revealed a plethora of factors influencing the adoption of particular technologies. From this, two factors were selected as being most appropriate to the study of SMDs in view of the inherent mobility of this technology and the hedonistic value derived from its usage.

Perceived Mobility Value (PMV)

Perceived enjoyment refers to 'the extent to which the activity of using the computer (technology) is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated' (Davis, Bagozzi & Warshaw 1992). The perceived mobility value introduced by Seppälä and Alamäki (2003) has a dual influence on perceived usefulness. Perceived mobility value (PMV) denotes user awareness of the mobility value of

SMDs. Mobility has three different elements including convenience, expediency and immediacy (Seppälä & Alamäki 2003). Mobility permits users to gain access to service/information anywhere at any time via mobile devices. In other words, mobility brings the ability to guide and support users in new situations when and where it is necessary. Previous studies found that mobile users valued efficiency and availability and these advantages are a result of the 'mobility' of a mobile device (Chen, Kao & Sheu 2003; Hill & Roldan 2005; Ting 2005). Therefore, SMDs adoption is valuable because of its mobility. Consequently, the perceived mobility value is a critical factor of individual differences affecting users' behaviours.

Perceived Enjoyment (PE)

Mobility enables users to receive and transmit information anytime and anywhere (Anckar & D'Incau 2002; Coursaris & Kim 2011; Hill & Roldan 2005; Ting 2005). The mobility associated with time-related needs will encourage users to adopt a mobile technology since enhanced accessibility is expected to affect dynamic interaction and high levels of engagement (Anckar & D'Incau 2002, p. 48).

The concept of perceived enjoyment (PE), adapted from Davis et al. (1992), means that users feel enjoyment from the instrumental value of using SMDs. Prior studies on technology acceptance behaviour examined the effects of perceived enjoyment on perceived ease of use (Igbaria, Parasuraman & Baroudi 1996; Venkatesh, Speier & Morris 2002; Yi & Hwang 2003). New technologies that are considered enjoyable are less likely to be difficult to use.

There is a causal relationship between perceived enjoyment and attitude. When users feel that M-learning is enjoyable, the stimulus of happiness in turn enhances their perception of M-learning. Venkatesh (2000) found that perceived enjoyment indirectly influences users on adoption. Other research showed that attitudinal outcomes, such as happiness, pleasure and satisfaction, result from the enjoyable experience (Childers et al. 2001; Moon & Kim 2001; van der Heijden 2004; Yu et al. 2005). These findings indicate that enjoyment highly correlates with users' positive attitudes.

Constructs developed from focus group study

While there are millions of mobile phones that business people use around the world, the SMDs combine the features of many different products into one package. Anecdotal information suggests that the growing integration of a number of diverse applications into a single mobile platform and device has influenced the rapid uptake of SMDs (O'Reilly & Duane 2010). To explore the impact that this was likely to have on the technology adoption model in the context of SMDs, a focus group study was conducted.

Activity-based Usage

It was found that the experienced user group categorised their usage of their SMDs into four or more discreet activities (entertainment, education, work, business and social networking), while the less experienced user group categorized the same applications into just two different groups (business and social) (see Table 1). The participants of the focus group placed much importance on the ability of SMDs to be able to support a variety of applications and functions for distinctly different purposes on a single device and platform, therefore suggesting this as a factor to be considered for inclusion in conjunction with the TAM model when determining the likely uptake of Smart Mobile Devices.

Table 1: Activity-based Usage Findings (Source: Developed for this study)

Groupings by less experienced users				
Social			Business	
Games, Facebook, Twitter, e-mail, Skype, PayPal, GPS, shopping list, IQ test, live TV, fitness, YouTube, Internet, e-books,			E-mails, conferencing (Skype), banking, shares, calendar, business programs, language converter, Internet.	
Grouping by more experienced users				
Education	Entertainment	Social Network	Productivity	Business
Study, Books, Email, Dictionary	Music, video, pictures, Camera, Books, News, Games	GPS, Email, IM, Social Network sites	Organiser, Business processes, Email Business, Internet (Google/Wikipedia)	M-commerce, Banking, Books, Clock, Alarm, Notepad, GPS
All				
Books, Notepad, GPS, Clock/Alarm, Email, Information, Telephone, Camera , etc.				

Consequently, activity-based usage drives the use of the device. Equally, the use of the device is driven by the applications that are chosen and loaded on the device. Thus, the activity-based usage for SMDs can be grouped as indicated in Figure 1 below, and then integrated into our model presented later.

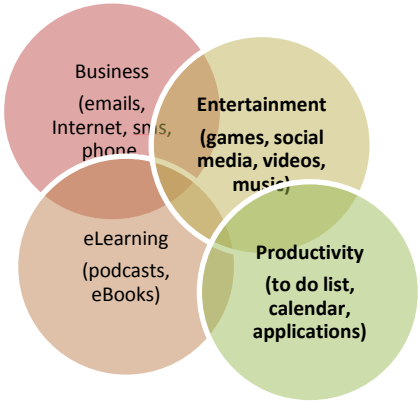


Figure 1: Activity-based Usage

Device characteristics

System characteristics are those salient features of a system that can help individuals develop favourable (or unfavourable) perceptions regarding the usefulness or ease of use of a system (Venkatesh & Bala 2008). While the perceived characteristics in the Diffusion of Innovation model developed by Rogers (1995) aims to be generalizable across all innovations, in specific applications it is more appropriate to study perceived benefits in terms of features particular to that innovation using a multi-attribute model (Roberts & Urban 1988). For the purposes of this study, the characteristics of a smart mobile device have been classified into hardware (external look-and-feel) and software (apps) components.

Previously available only in limited environments, new touchscreen and voice technology in SMDs provides an alternative to the traditional keyboard, mouse and pointing interfaces. The

implications of these devices are that there has been a paradigm shift in the way that we interact and communicate using this technology (Deal 2008). The familiar buttons, switches, pens and keyboards have been replaced by images, text and icons that only require a touch or voice instruction. In addition, innovative features where users have the ability to pinch-in/pinch-out, pan, flick, scroll and swipe through a touch or voice interface provide for seamless and immersive interaction with the content of the device. With the reduced effort and skills now necessary to enter information and control devices and systems, tasks perceived to be complex can be accomplished with greater ease, comfort and confidence. Commercial sales (EMarketer 2012) and anecdotal evidence also suggest that the move to more ergonomically designed Smart Mobile Devices, with their improved screen sizes and resolution, sound quality and devices' construction material, have facilitated the uptake and ubiquity of these devices.

Most applications on SMDs are available online either free or for relatively low cost, are easy to install and are generally peer reviewed. The user-review process provides feedback and ratings that help buyers identify, evaluate and select applications from a central, usually trusted, distribution system (for example, iTunes). Rogers (1995) has also shown that trialability, that is, the extent to which a technology can be evaluated on a limited scale, is more important for innovators and early adopters than for those who purchase the innovation later. Buyer's remorse or cognitive dissonance is low in this emerging environment as the cost of applications is low or free and users expect that the only way to really understand if the application will work for the individual is to try the application. The true measure of cogitative dissonance is the disparity between the buyer's expectations and satisfaction with the purchase. Consumers will often try to reduce cognitive dissonance by justifying their decisions and seeking positive support from feedback sites and forums reinforcing their decision to buy. Although the purchase and use of applications is of low social and monetary risk and, as such, the cognitive dissonance is also low, it can be still significant if the applications perceived value either in cost, reputation or social status increases after the event. Another dimension to the acquisition of applications is the identification that the process of acquiring and uploading an application has been simplified to an extent that most users can download and install an application with the touch of an icon which, in comparison to downloading software for a PC-based device, is relatively seamless, simple and secure. From our qualitative group analysis it is clear that the existing models do not truly reflect the reasons that people adopt or actually use a particular device and their respective applications. It is also clear that the device characteristics and the activity-based usage for the device are factors that need to be introduced as moderating variables.

PROSPOSED MODEL

In conjunction with the TAM, and using the developed constructs, we proposed the following research model (Figure 2).

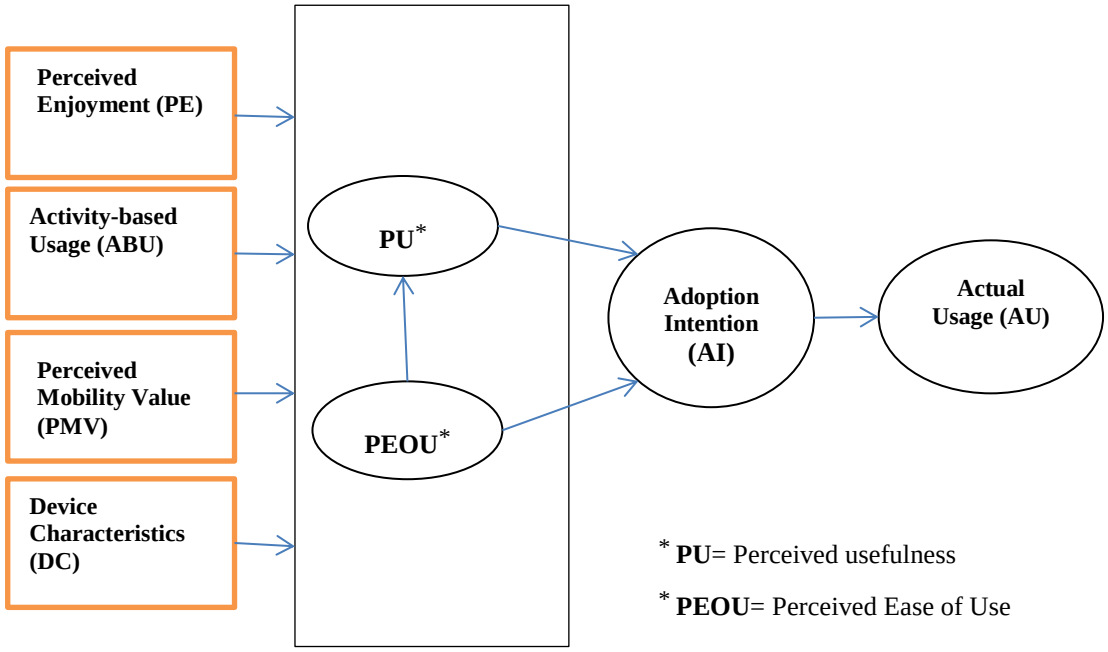


Figure 2: Proposed research model

Having developed and defined the elements of the model, and then ratifying the inclusion of the device characteristics and activity based usage as determinants in the model, it is necessary to determine if the model will hold up to quantitative testing. A survey of academic, practitioners and mainstream users is proposed as a sampling ground for this test. A pilot instrument was developed and refined by academic peers and survey experts to ensure its validity and reliability before full scale administration of the survey.

The overriding objective of the survey will be to address the research question posed, namely, to what extent do Perceived Mobility Value, Perceived Enjoyment, Activity-based Usage and Device Characteristics influence the adoption of SMDs—and this will be achieved by addressing the eight parent hypotheses identified below, which are the foundation of the questionnaire.

H1: There is a positive relationship between PMV and PU

H2: There is a positive relationship between PE and PU

H3: There is a positive relationship between PEOU and PU

H4: There is a positive relationship between PU and AI

H5: There is a positive relationship between PEOU and AI

H6: There is a positive relationship between AI and AU

H7: There is a moderating effect by ABU on PU

H8: There is a moderating effect by DC on PEOU

PRELIMINARY MODEL TESTING

As part of a pilot study a survey instrument was developed using items from earlier studies and items were developed for the new proposed constructs.

The survey was sent to students participating in distance education courses and ranged from undergraduate to postgraduates across age groups of 18 to 60 of both gender. The students were asked to complete the questionnaire using Survey Monkey, and the summary report of frequencies is presented using Survey Monkey's presentation software.

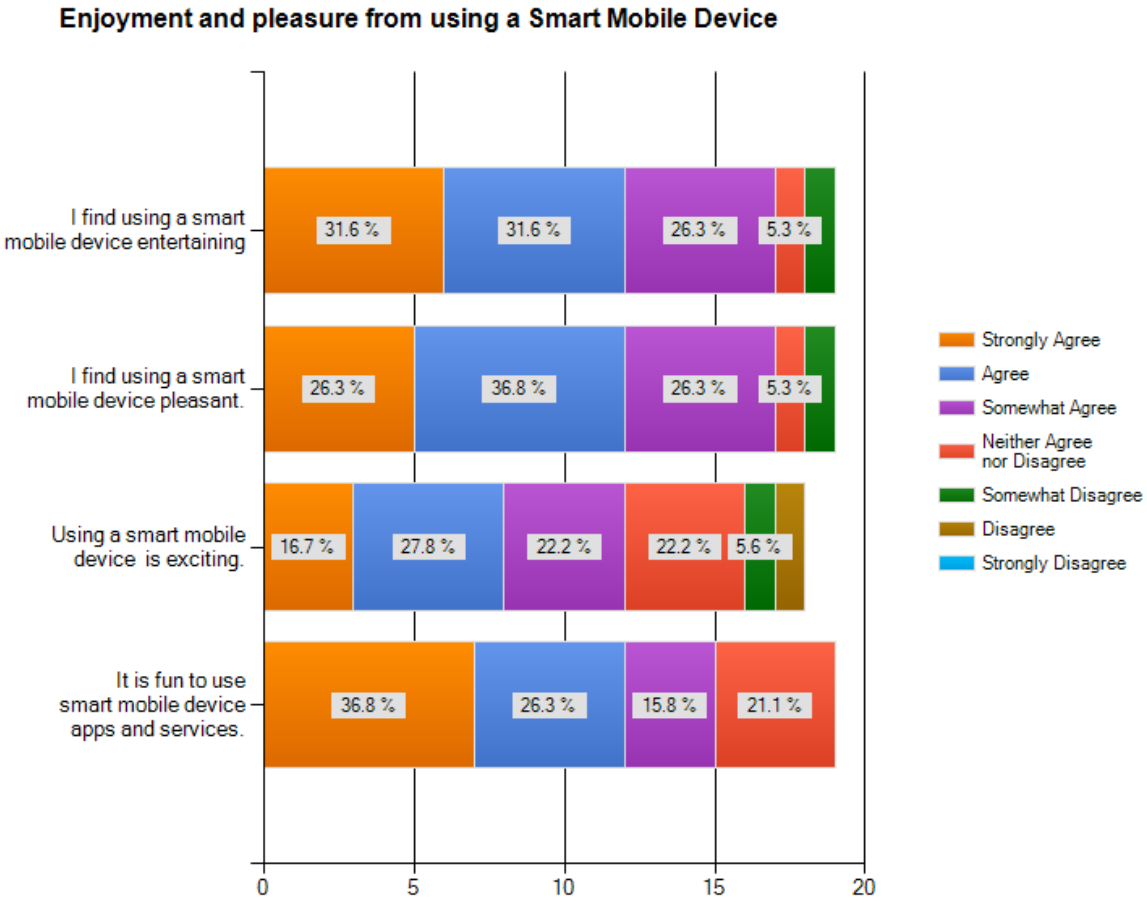
This sample will allow researchers the opportunity to interrogate the survey participants, thereby refining the structure, wording and content of the instrument and, more importantly, enhancing the reliability and validity of the instrument in relation to the research hypotheses specifically and the proposed model generally. On completion of this pilot stage the final instrument will be administered using online media to a wider population that includes users and non-users of smart mobile devices.

DISCUSSON OF PRELIMINARY FINDINGS

While the questionnaire was statistically robust for a pilot study (n>30), it must be recognised that further analysis other than frequencies would be misleading. Thus, the overall findings from the survey are reviewed with frequencies and presented below.

While earlier studies have proven the reliability of the questions and scales in the questionnaire, the analysis of the response to each question offers an indication as to the importance of each item to the collective participants, but more importantly to the four constructs under consideration. Each construct will be considered in turn with responses related to the questions for that construct. The discussion begins with Perceived Enjoyment and proceeds through Activity-based Usage, Perceived Mobility Value and Device Characteristics.

Perceived Enjoyment



As seen in Figure 3, four statements are used for this construct.

This figure shows the four questions related to perceived enjoyment. Clearly the *use* base questions of perceived enjoyment rate more highly than the *emotive base* questions. However, the overall level of agreement is over 66% of possible responses. This suggests that perceived enjoyment is an important construct for the model in understanding the adoption of SMDs.

Activity based usage

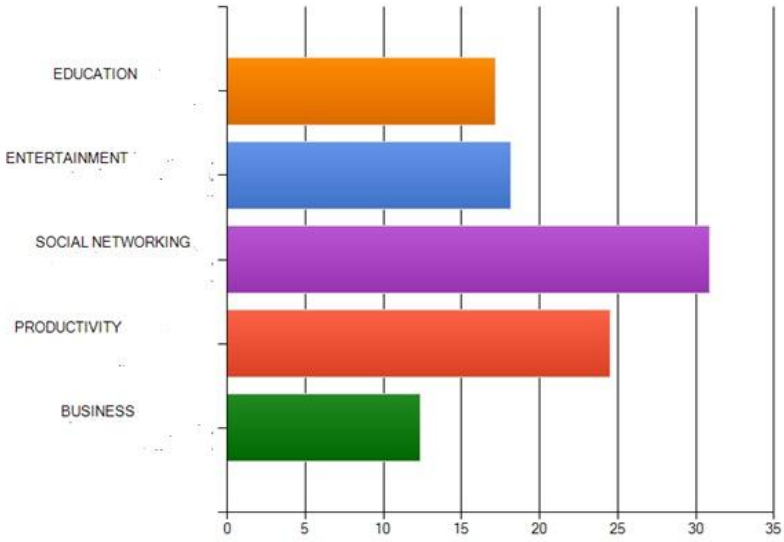


Figure 4, highlights five activities titles developed from the focus group findings. The use of SMDs for social media and productivity suggests a change in habit in using the device to keep current and relevant in the social media and personal life.

Perceived Mobility Value

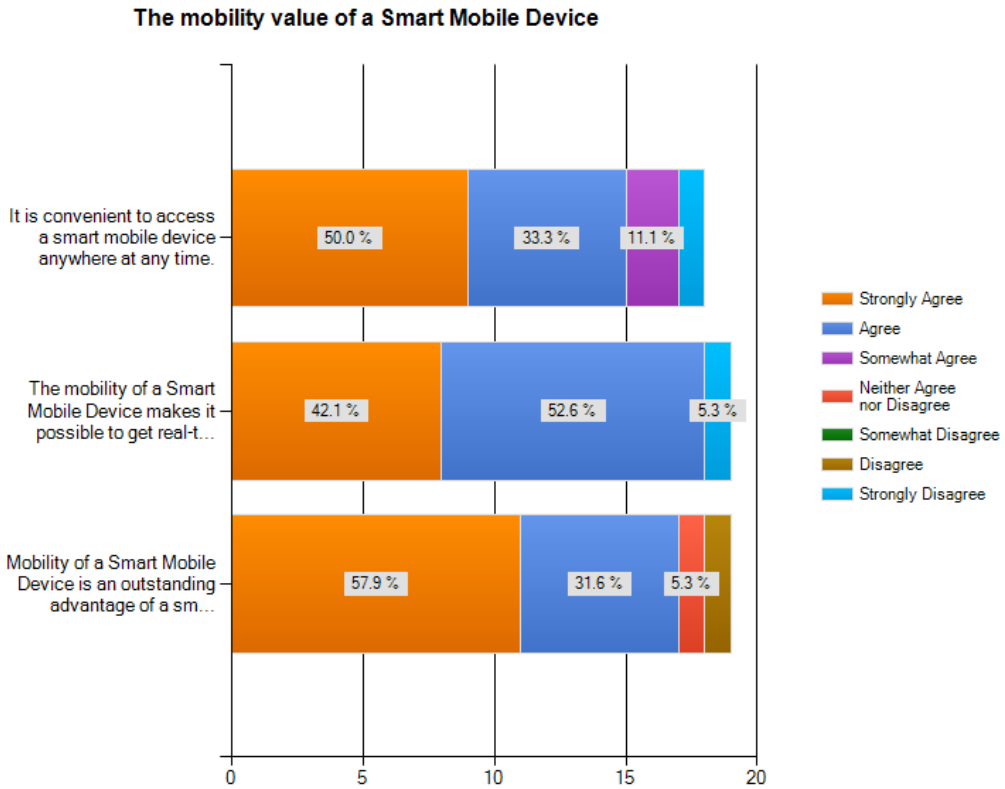
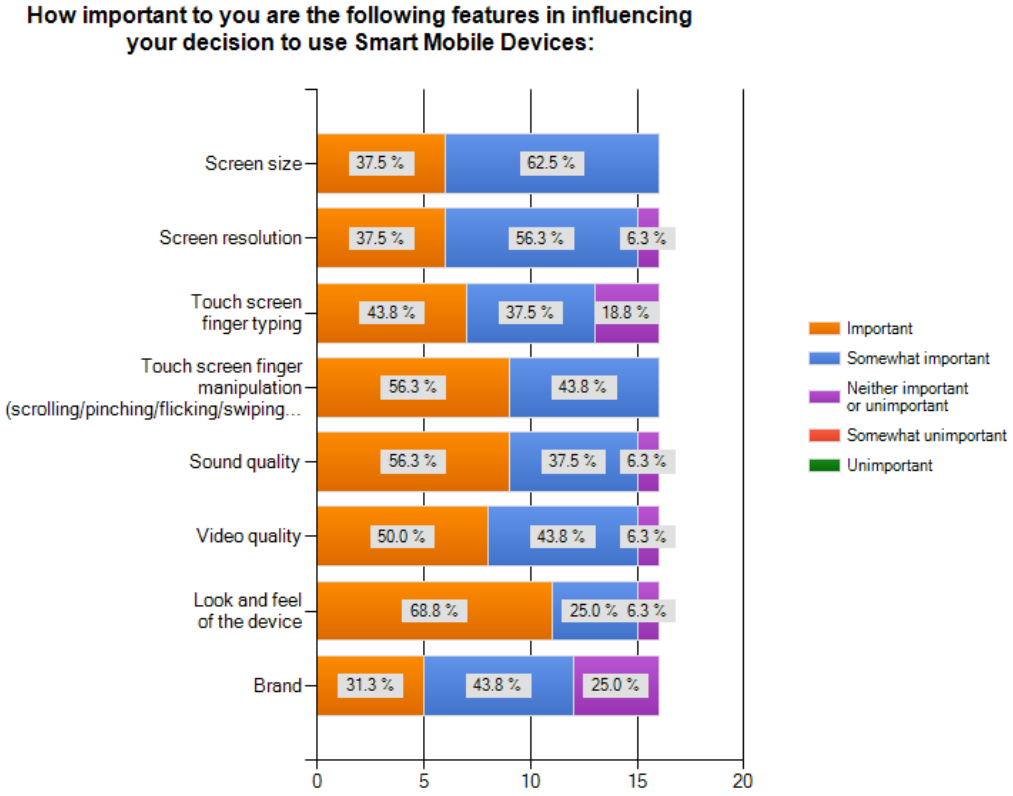


Figure 5 reviews the respondents' level of agreement to statements regarding the mobility construct of SMDs. The three statements tend to increase in strength from the first to the third. Interestingly, it is the strongest statement that has the highest level of agreement. However, all three statements have over 89% level of agreement to the statements, suggesting that mobility is also an important construct for the model on the adoption of SMDs.

Device Characteristics



Finally, Figure 6 presents an importance scale on eight statements on the features of SMDs. Again the statement can be grouped. The highest rated statement is in relation to the overall look and feel of the SMD. The next grouping relates to the ability to access information from the SMD in terms of video, sound and access to the screen images by scrolling, flicking and swiping. The final group of statements are about product characteristics such as the screen size and resolution, branding of the device and the touch screen function. These findings suggest that while device characteristics are a construct for determining the uptake of SMDs, it also suggests that some device characteristics are more important than others.

Ultimately, the pilot study confirms the proposition developed from the qualitative research that the four constructs—Perceived Enjoyment, Activity-based Usage, Perceived Mobility Value and Device Characteristics—are found to be statistically important, as indicated in the finding from the pilot study. Thus, these findings offer confidence in suggesting these constructs as potential determinants of SMD adoption, and will be tested in the next phase of the research designed to determine the degree of a causality (if any) and confirm the model.

CONCLUSION

There is limited research in the IT implementation literature that deals with the role that the integration of a diverse range of applications and functionality into a single device or platform plays in influencing the uptake of the technology. Coupled with a new paradigm shift in the way the device is used and physically accessed, there is a need to investigate the accelerating impact these factors have on the traditional paths to adoption and diffusion of mobile devices in particular.

In this paper, we have proposed modification to the TAM model consistent with previous research. Further, we have specifically included three moderating variables perceived mobility value, which has been established in earlier research, and included two new dimensions of activity-based usage and device characteristics. This proposed model identifies that these three moderating variables impact on the adoption intention and actual usage of smart mobile devices. This model has been developed from two previous theories and an early phase of research, where qualitative group research identified the moderating variables of activity-based usage and device characteristics. It is believed that at the conclusion of this study there will be sufficient evidence to suggest that researchers will be able to identify adoption intention and actual usage of these devices based on the TAM model, but including the moderating variables of perceived mobility value, device characteristics and activity-based usage.

REFERENCES

Anckar, B & D'Incau, D 2002, 'Value creation in Mobile Commerce: findings from a consumer survey', *Journal of Information Technology Theory & Application*, vol. 4, no. 1.

Carlsson, C, Carlsson, J, Hyvönen, K, Puhakainen, J & Walden, P 2006, 'Adoption of Mobile Devices/Services – Searching for Answers with the UTAUT', paper presented to 39th Hawaii International Conference on System Sciences - 2006, Hawaii.

Chen, YS, Kao, TC & Sheu, JP 2003, 'A mobile learning system for scaffolding bird watching learning', *Journal of Computer Assisted Learning*, vol. 19, no. 3, pp. 347-59.

Childers, TL, Carr, CL, Peck, J & Carson, S 2001, 'Hedonic and Utilitarian Motivations for Online Retail Shopping Behaviour', *Journal of Retailing*, vol. 77, no. 4, pp. 511-35.

Coursaris, CK & Kim, DJ 2011, 'A Meta-Analytical Review of Empirical Mobile Usability Studies', *Journal of Usability Studies*, vol. 6, no. 3, pp. 117-71.

Davis, FD 1986, 'A Technology Acceptance Model for testing new end-user information systems: Theory and results', *MIT Sloan School of Management, Cambridge, MA*.

---- 1989, 'Perceived usefulness, perceived ease of use and user acceptance of information technology', *MIS Quarterly*, vol. 13, no. 3, pp. 319-40.

Davis, FD, Bagozzi, RP & Warshaw, PR 1992, 'Extrinsic and intrinsic motivation to use computers in the workplace', *Journal of Applied Social Psychology*, vol. 22, no. 14, pp. 1111-32.

Deal, WF 2008, 'Communication Technology: The Magic of Touch', *Technology Teacher*, vol. 68, no. 2, pp. 11-8.

EMarketer 2012, *Tablet shopping growing, but retailers must keep up*, viewed 22 June 2012 <http://www.emarketer.com/Mobile/Article.aspx?R=1009120>.

Gartner 2010, *Gartner Says Worldwide Mobile Phone Sales Grew 17 Per Cent in First Quarter 2010*, Gartner Press Release, viewed June 2011 <http://www.gartner.com/it/page.jsp?id=1372013>.

---- 2011, *Gartner Says 428 Million Mobile Communication Devices Sold Worldwide in First Quarter 2011, a 19 Percent Increase Year-on-Year*, Gartner Newsroom, viewed May 2011 <http://www.gartner.com/it/page.jsp?id=1689814>.

Hill, TR & Roldan, M 2005, 'Toward third generation threaded discussions for mobile learning: opportunities and challenges for ubiquitous collaborative environments', *Information Systems Frontiers*, vol. 7, no. 1, pp. 55-70.

Igbaria, M, Parasuraman, S & Baroudi, J 1996, 'A motivational model of microcomputer usage', *Journal of Management Information Systems*, vol. 13, no. 1, pp. 127-43.

Moon, J-W & Kim, Y-G 2001, 'Extending the TAM for a World-Wide-Web context', *Journal of Information and Management*, vol. 38, no. 4, pp. 217-30.

Noll, J 2006, 'Services and applications in future wireless networks', *Teletronikk*, vol. 3, no. 4.

O'Reilly, P & Duane, A 2010, 'Smart Mobile Media Services: Consumer Intention Model', paper presented to 8th International Conference on Advances in Mobile Computing & Multimedia (MoMM2010), Paris, France, 8-10 November, 2010.

Pagani, M 2004, 'Determinants of Adoption of Third Generation Mobile Multimedia Services', *Journal of Interactive Marketing Intelligence and Planning*, vol. 18, no. 3, pp. 46-59.

Roberts, J & Urban, GL 1988, 'Modelling multiattribute utility, risk, and belief dynamics for new consumer durable brand choice', *Management Science*, vol. 34, no. 2, pp. 167-85.

Rogers, EM 1995, *Diffusion of innovations*, Free Press, New York.

Sciencewatch 2009, *Technology Acceptance Model*, viewed January 2011 <http://www.vvenkatesh.com/Files/Sciencewatch.pdf>.

Seppälä, P & Alamäki, H 2003, 'Mobile learning in teacher training', *Journal of Computer Assisted Learning*, vol. 19, no. 3, pp. 330-5.

Shin, D-H 2009, 'Towards an understanding of the consumer acceptance of mobile wallet', *Computers in Human Behaviour*, vol. 25, pp. 1343–54.

Stewart, DW & Pavlou, PA 2002, 'From Consumer Response to Active Consumer: Measuring the Effectiveness of Interactive Media', *Journal of the Academy of Marketing Science*, vol. 30, no. 4, pp. 376-96.

Ting, RYL 2005, 'Mobile learning: current trend and future challenges', paper presented to Fifth IEEE International Conference on Advanced Learning Technologies (ICALT 2005).

van der Heijden, H 2004, 'User Acceptance of Hedonic Information Systems', *MIS Quarterly*, vol. 28, no. 4, pp. 695-704.

Venkatesh, V & Davis, FD 2000, 'A theoretical extension of the technology acceptance model: Four longitudinal field studies', *Management Science*, vol. 46, no. 2, pp. 186-204.

Venkatesh, V & Bala, H 2008, 'Technology Acceptance Model 3 and a research agenda on interventions', *Decision Sciences*, vol. 39, no. 2, pp. 273-315.

Venkatesh, V, Speier, C & Morris, MG 2002, 'User acceptance enablers in individual decision making about technology: toward an integrated model', *Decision Sciences*, vol. 33, no. 2, pp. 297-316.

Venkatesh, V, Morris, MG, Davis, GB & Davis, FD 2003, 'User acceptance of information technology: Toward a unified view', *MIS Quarterly*, vol. 27, no. 3, pp. 425-75.

Wu, Y, Tao, Y & Yang, P 2007, 'Using UTAUT to explore the behavior of 3G mobile communication users', paper presented to IEEE International Conference on Industrial Engineering and Engineering Management.

Yi, MY & Hwang, Y 2003, 'Predicting the use of web-based information systems: self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model', *International Journal of Human-Computer Studies*, vol. 59, pp. 431-49.

Yu, J, Ha, I, Choi, M & Rho, J 2005, 'Extending the TAM for a t-cornmerce', *Journal of Information and Management*, vol. 42, no. 7, pp. 965-76.