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## The moderating influence of device characteristics and usage on user acceptance of Smart Mobile Devices

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### Abstract

*This study seeks to develop a comprehensive model of consumer acceptance in the context of Smart Mobile Device (SMDs). This paper proposes an adaptation of the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT2) model 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 Activity-based Usage and Device Characteristics are posited to moderate the impact of the constructs empirically validated in the UTAUT2 model. Through an important cluster of antecedents the proposed model aims to enhance our understanding of consumer motivations for using SMDs and aid efforts to promote the adoption and diffusion of these devices.*

### Keywords

Smart mobile Device, TAM, UTAUT, UTAUT2, 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. Mobile devices have evolved over the years both in design and usage, generating new opportunities and enhancing value and productivity (Stewart and Pavlou 2002), becoming more powerful, more accessible and more common as they connect to the Internet and as they support a multitude of diverse applications.

In the USA over the next two years, eMarketer (2012a) expects more than 26 million mobile phone users to turn to smartphones. Tablet penetration is expected to increase even more quickly in the USA, from a user base of nearly 55 million by the end of 2012 to almost 90 million in the next two years. By 2014, more than one in three US internet users will have a tablet device (eMarketer 2012a).

These smart devices, which offer advanced computing ability and connectivity, combining 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, and when compared to 13.6 percent in 2009 this amounts to an increase of nearly 49 percent. The changing technology and environment have given rise to a number of competing mobile operating systems that support an integrated touch-screen 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 providing increasing 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 various activities, it raises the question as to the extent to which these groups of activities and other factors affect their adoption and continued usage. The aim of this research is to investigate the activities and factors that are identified in this study and to determine their likelihood of impacting the uptake of SMDs.

This article provides a literature review on smart mobile devices and on the theoretical framework used to investigate smart mobile devices and their users. Next, it describes the findings of our focus group research with regards to activity-based usage and proposes a modified research model. The article goes on to describe our proposed research method and sets out the strategy for empirically validating the model along with the hypotheses that will be tested. A discussion on the implications for theory and practice follows with a presentation of our conclusions.

## LITERATURE REVIEW

### *Trends in Smart Mobile Device*

Smart Mobile Devices continue to blur the once established distinctions between phones and computers. Devices that were once considered Personal Digital Assistants (PDAs), have evolved into smart devices. These Smart Mobile Devices are typically defined by ubiquitous broadband network connectivity, multiple gigabytes of data storage and advanced graphical user interfaces.

One trend driving growth in Smart Mobile Devices is the lower cost and increased market share of internet-enabled mobile phones, tablets and related devices. In the past, desktops and laptops were the primary source of Internet access but with widespread mobile Internet availability, innovations in content, commerce, entertainment, education and gaming are coming to the fore. Many of these innovations recognize the information needs of mobile users are very different from the information needs of the same user while at a desktop computer (Valhouli 2010).

Another trend is the convergence of digital content from a variety of sources including movies, TV shows, games, photos, books, magazines, newspapers, video clips and music into a single hand-held device. It is commonplace today for a smart device to act as a mobile office, social tool, and an entertainment centre all rolled into one. This versatility of SMDs has provided users with the opportunity to use the devices in a variety of ways and for new purposes that many have not thought of or predicted.

An innovative feature of these devices has been the advancements in human computer interaction particularly with regards to touch-screen, voice and interface design (Pirttikingas et al. 2008). In addition to providing a new user-experience this has also opened the potential of adoption of these devices by a new market segment that includes those averse to technology, the elderly and the disabled.

As a consequence of these, namely, the mobility of the devices, the convergence of applications and an innovative interface, there has been a rapid growth in the uptake of SMDs. These trends can be influenced by some of the challenges that the SMDs potentially face, particularly in relation to users' security and privacy concerns. In addition to developing trust in the provider's hardware and software of the device, a specific area of concern in this regards is related to mobile payments and transactions and users' willingness to engage in online mobile Commerce, online payments and the virtual stores (Ally 2011).

The unique characteristics of these devices coupled with the challenges outlined above give rise to the need to investigate these attributes with a view to determining the adoption of SMDs. These 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 (for example, Carlsson et al. 2006; Pagani 2004; Shin 2009; Wu et al. 2007). To this end we commence with a discussion on TAM and UTUAT2 and their 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; Davis 1989; Venkatesh and Bala 2008; Venkatesh and Davis 2000; Venkatesh et al. 2003) and many empirical studies have tested the TAM model and have 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 (Shin 2009).

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 particularly areas of research (Sciencewatch 2009). It is argued that the TAM may have only a limited ability to explain SMD adoption; is too generalized to 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. Most importantly, the TAM tends to neglect the social context in which a technology is being adopted. For example, the TAM does not consider social influence (Malhotra and Galletta 1999) or the various barriers (Mathieson et al. 2001) that are likely to deter a user from adopting a technology such as trust, security, privacy (Shin 2009) and cost concerns (Venkatesh et al. 2012). This study proposes that a number of factors related to SMDs have emerged that make the parsimonious nature of the TAM as an independent model is inadequate for our study.

#### *Unified Theory Acceptance and Use of Technology (UTAUT2)*

For the reasons explained above, there has been a growing trend for researchers to extend the TAM with a number of other motivational variables and has been revised to include additional constructs for specific contexts. The Unified Theory Acceptance and Use of Technology (UTAUT2) developed by Venkatesh et al. (2012) incorporates three constructs into the original UTAUT model (Venkatesh et al. 2003). These are hedonic motivation, price value and habit with age, gender, and experience hypothesized to moderate the effects of these constructs on behavioural intention and technology use. Also included in UTAUT2 were the original constructs of facilitating conditions and social influence. Compared to UTAUT, the extensions proposed in UTAUT2 produced a substantial improvement in the variance explained in behavioural intention and technology use (Venkatesh et al. 2012).

In addition to the general causalities found in TAM and UTAUT that have been widely applied to emerging technologies, Shin (2009) have confirmed the relation between attitude (from the Theory of Reasoned Action (TRA) of Fishbein & Ajzen (1975)) and intention in their hybrid model developed to investigate mobile wallet adoption.

The purpose of the current study is to empirically extend the UTAUT2 model by incorporating the TAM and developing new variables specific to the context of our study in order to explain the development of individuals' behavioural intentions towards, and use of, Smart Mobile Devices. In addition to the constructs identified in this model (see Table 1) we propose additional factors to be included based on the focus group study that was conducted as a precursor to developing our integrated model as well as two variables related to trust and perceived security. The identification of these new factors will be discussed in the next section.

## **DEVELOPMENT OF NEW CONSTRUCTS**

While there are millions of mobile phones that consumers and 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.

#### *Focus-Group Study*

To identify and categorize the types of activities that these devices are used for we adopted a qualitative methodology using a self-selecting focus group technique to review and refine the Activity Based Usage concept for SMDs. This approach ensures confirmability, transferability, dependability and credibility (Cooper and Emory 1995; Healy and Perry 2000; Lincoln and Guba 1985) and aids to complement the literature for the research questions at hand. Specifically, postgraduate students from an information systems management course were segmented based on their interest, familiarity and experience with touchscreen technology and the more recent smart mobile devices.

#### *Findings*

An analysis of the two groups revealed that the self-identifying more experienced group recognised and used mobile media devices within four or more discreet activities (entertainment, education, work, business and social networking), while the less experienced group recognised the same technology, applications and mobility as two

different groups (business and social) (see Table 2). This initial inspection of the collected primary data from the two groups reflects the need to consider the activity based usage in conjunction with the TAM/UTAUT model for the likely impact that purpose-of-use has on the acceptance of emerging smart mobile devices.

Table 1: Theoretical constructs from existing adoption models

CONSTRUCT	DEFINITION
<i>Perceived Usefulness (TAM)</i>	The degree to which an innovation is perceived as being better than its precursor (Moore and Benbasat 1991)
<i>Perceived ease of use (TAM)</i>	The degree to which an innovation is perceived as being difficult to use (Moore and Benbasat 1991)
<i>Attitude (TRA)</i>	An individual's positive or negative feeling about performing the target behaviour (Fishbein and Ajzen 1975)
<i>Behavioural Intention (TAM)</i>	"the strength of one's intention to perform a specified behaviour" (Fishbein and Ajzen 1975, p. 288)
<i>Hedonic motivation (UTAUT2)</i>	The fun or pleasure derived from using a technology (Brown and Venkatesh 2005) and 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 et al. 1992)
<i>Price value(UTAUT2)</i>	The consumers' cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them (Dodds et al. 1991)
<i>Habit (UTAUT2)</i>	Conceptualized as the extent to which people tend to perform behaviours automatically because of learning (Limayem et al. 2007).
<i>Facilitating conditions (UTAUT)</i>	Consumers' perceptions of the resources and support available to perform a behaviour (Brown and Venkatesh 2005; Venkatesh et al. 2003)
<i>Social influence (UTAUT)</i>	The individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations (Thompson et al. 1991)
<i>Socio-demographics (UTAUT2)</i>	Individual's age, gender, experience

Table 2: Activity-based Usage Findings (Source: Developed for this study)

<b>Groupings by less experienced users</b>				
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.		
<b>Grouping by more experienced users</b>				
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
<b>All</b>				
Books, Notepad, GPS, Clock/Alarm, Email, Information, Telephone, Camera, etc.				

### *Activity-based Usage*

The ability to support a variety of applications and functions for distinctly different purposes on a single device and platform adds a new factor for consideration when determining the likely uptake of Smart Mobile Devices. We expect that some of the constructs in the proposed model will be moderated by the types of usage that users find appropriate to their needs, as categorised in Figure 1. The research identifies activity-based usage as a moderating variable due to an understanding that owners of smart mobile devices tend to limit the range and capacity of the device to their essential needs at the time of first use. Subsequent purchase and use of applications in this environment means that the user must understand what they want the application to do and how they want the application to work either within their device or within the broader cloud or PC or Macintosh-based technology that they are embracing. Observational research identifies that when owners of Smart Mobile Devices meet they usually discuss recent application findings that were found to be helpful. Further, application reviews are held against the application itself, thus making the user the buyer, user and reviewer of the various programs that are uploaded to the device. The implications and consequences of this behaviour are such that the user tends to focus on the activities that they deemed necessary for their particular use of the device. It just becomes a self-fulfilling prophecy that the users will express that to the applications that are consistent with their expectations and needs for the use of the smart mobile device. 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.

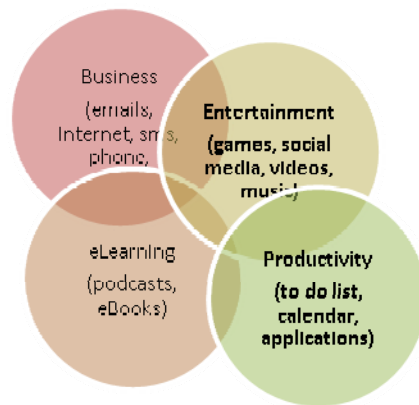


Figure 1: Activity-based Usage

### *Device characteristics*

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 and 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 touch-screen and voice technology in SMDs provides an alternative to the traditional keyboard, mouse and pointing interfaces. The implications of these devices is 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 2012b) 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 cognitive dissonance is the disparity between the buyer's expectations and the satisfaction with the purchase. Consumers will often try to reduce cognitive dissonance by justifying their decisions by 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.

#### *Trust*

Trust is proposed in this study as an antecedent variable to the intention to use a Smart Mobile Device. It has been defined as the belief that vendors will perform some activity in accordance with users' expectations (Gefen et al. 2004; Gefen and Straub 2004). Users often feel more uncertain about mobile vendors and the outcomes of mobile transactions (Siau and Shen 2003). It also follows from this definition that trust in the vendor to offer a reliable device and service, and a safe and secure environment can influence a user's behavioural intentions.

#### *Perceived Security*

This study adapts the definition of perceived security as defined by Shin (2009) in the context of mobile wallets to our study as the degree to which users believe that using a particular SMD and its environment will be secure. Security in interactive spaces does not depend on technical security measures alone. Shin and Kim (2008) show that the feeling of security is largely determined by the users' feeling of control of the interactive system. In line with previous studies, the current study approaches perceived security from a broader perspective that includes not only technical aspects such as confidentiality and authentication (Flavian and Guinaliu 2006), but also the customer's comprehensive sense of security and well-being.

#### *Discussion*

An essential paradigm shift in the provision of software applications has been the decoupling of the software from the device and manufacturer resulting in the ability of users to customize their device to cater for their specific needs. The new business model for the management of these applications fosters a more open development environment in which the primary beneficiaries are the consumers who have access to independently developed applications at relatively low cost prices. To extend the existing TAM and UTAUT2 model, we introduce the above constructs and integrate them with relevant ones from previous studies that have the potential to influence adoption of SMDs.

## **MODEL DEVELOPMENT**

This study proposes an adaptation of the TAM and UTAUT2 model that incorporate as variables trust, perceived security, perceived usefulness, and perceived ease of use as validated by Shin (2009) in their study on mobile wallets. Figure 2 presents the Smart Mobile Device acceptance/use model proposed for the purposes of this study. The research model postulates nine constructs (perceived usefulness, perceived ease of use, hedonic motivation, price value, habit, facilitating conditions, perceived security, trust and social influence) that determine behavioural intent and use behaviour.

Our study examines the socio-demographic characteristics (in particular, gender, age, education and income) and the potential of activity-based usage and device characteristics to have moderating influences on the primary constructs. Empirical studies have shown that age, income, and gender play a crucial role in affecting the strength and direction of various relationships in many models (Ha et al. 2007). It is argued by Venkatesh et al. (2003) that age and gender be included as moderators and this study will test for the levels of education and income for their potential moderating impact.

#### *Towards an integrated model*

For the reasons stated above, this study uses TAM and UTAUT2 model as the basis for the development of our hybrid model. The smart mobile device in this study is a specific context that calls for additional constructs, in particular trust and perceived security to better explain variances. Based on our focus group findings we also

include device characteristics and activity based usage as moderating variables in explaining behavioural intention and usage behaviour for SMDs. Placing these variables under the structure of our hybrid model integrates them into a coherent and parsimonious research model.

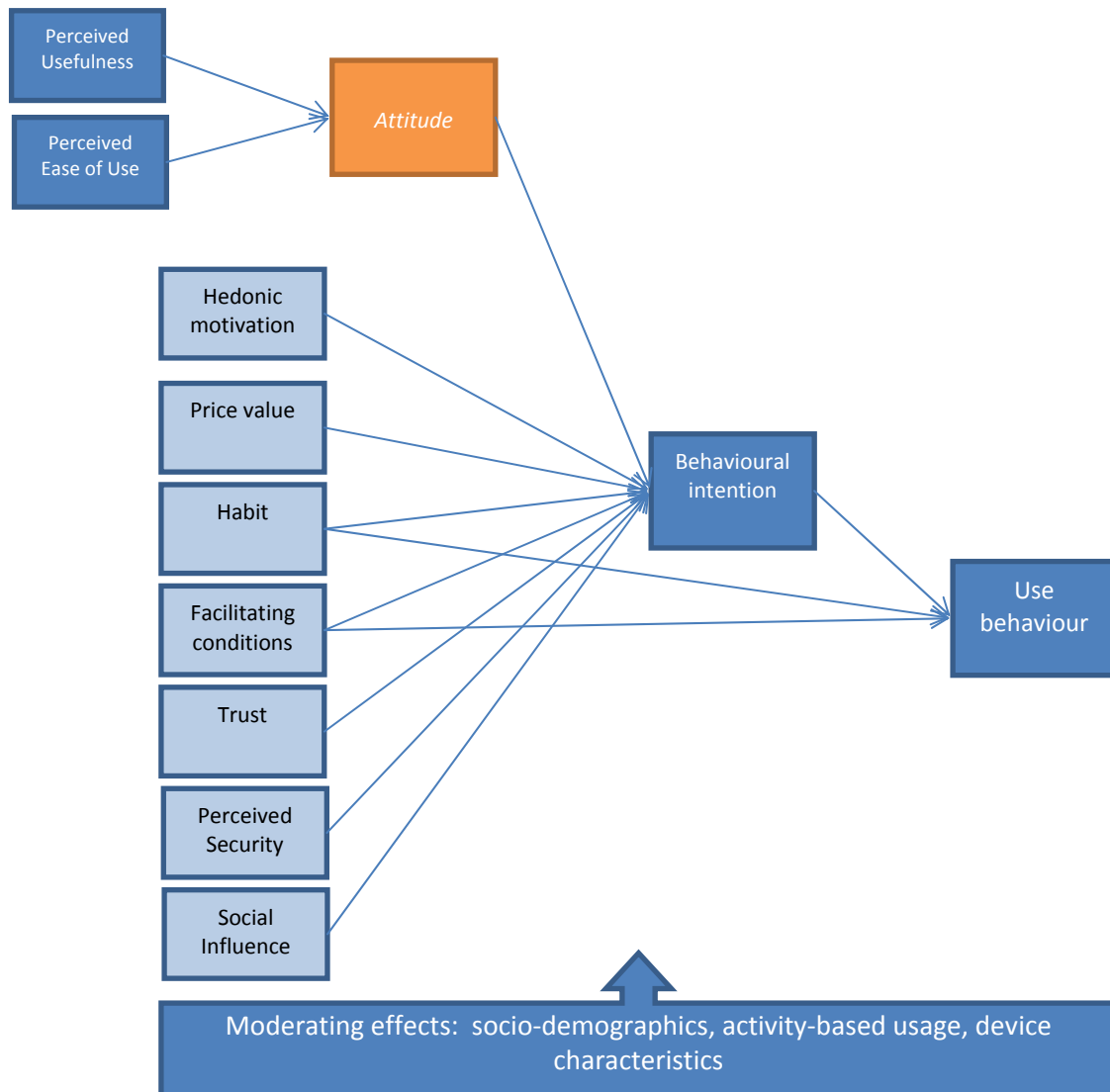


Figure 2: Proposed Hybrid Smart Mobile Device Acceptance Model

## HYPOTHESES

This overriding objective of the survey will be to address the research question posed, namely to what extent are the antecedents proposed in the model likely to influence the adoption of SMDs. This will be achieved by addressing the parent hypotheses as identified and described by Shin (2009) and Venkatesh et al. (2012) and will form the basis for the development of the survey instrument. A summary of the hypotheses developed for this study are listed below:

H1: Attitude toward SMDs has a positive effect on the intention to use an SMD.

H2: An individual's intention to use an SMD will have a positive effect on usage behaviour concerning the SMD.

H3: Perceived usefulness has a positive effect on attitude toward an SMD.

H4: Perceived ease of use has a positive effect on attitude toward an SMD.

H5: Perceived security has a positive effect on the intention to use an SMD.



- H6: Social influence positively influences intention to use an SMD.  
H7: Trust in virtual stores positively affects the intention to use an SMD.  
H8: Hedonic motivation positively influences the intention to use an SMD.  
H9: The price value positively influences the intention to use an SMD.  
H10: Facilitating conditions positively influence the intention to use an SMD.  
H11: Habit positively influences the intention to use an SMD.  
H12: Facilitating conditions positively influence the usage of an SMD.  
H13: Habit positively influences the usage of an SMD.

#### *Moderators*

The proposed model includes three moderators, namely socio-demographics (Carlsson et al. 2006; Venkatesh et al. 2012) and activity-based usage and device characteristics (as described above) which are posited to contribute to a better understanding of the complexity of technology acceptance by individuals. These new constructs developed for this study will be operationalized and measured with the further developed of the survey instrument.

#### *Data Collection*

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. A pilot test has been undertaken to examine the test-retest reliability and construct reliability using including academics and undergraduate students who utilise smart mobile devices. This sample allowed 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.

A survey of academic, practitioners and mainstream users is proposed as a sampling ground for this test. The survey will be administered online and responses will be collated and analysed using SPSS. On completion of this pilot stage the refined instrument will again be sent to the broader general population. Use will be made of existing databases that represent users and non-users of smart mobile devices. Two differently worded instruments were developed to cater for user and non-users of SMDs.

## **IMPLICATIONS FOR THEORY AND PRACTICE**

The findings will be of interest to both academic and practitioners. From a theoretical perspective, this study will provide an empirically validated model for identifying antecedents of user intention to adopt Smart Mobile Devices that are moderated by user demographics, device characteristics and usage. Although there are a number of studies that are presented in the mobile literature, few have used integrated models of trust and security, or ways to assess these factors in relation to SMDs. The recognition of the moderating role of demographics, device characteristics and type of usage is predicted to play a particularly notable role in this study. From a practical standpoint, the findings should guide the industry to develop applications that support users' needs and thereby enhance the usability and appeal of these devices. This will further enhance the adoption and diffusion of these devices amongst potential users.

## **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 ways 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.

This paper proposed modification to the TAM and UTAUT2 model consistent with previous research. Further, we have specifically included three moderating variables: user demographics, which have been established in earlier research, and two new dimensions of activity-based usage and device characteristics, and trust and perceived security from previous studies. 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 three previous theories and an early phase of the research where qualitative group research identified the moderating variables of activity-based usage and device characteristics. It is believed that 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 our hybrid SMD acceptance model by including the moderating variables of user and device characteristics and activity-based usage

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