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An Examination of Fit and the Use of Mobile Devices for Performing Tasks

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AN EXAMINATION OF TASK-TECHNOLOGY FIT AND THE USE OF MOBILE DEVICES FOR PERFORMING TASKS

by

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The content and format of the dissertation are appropriate and acceptable for the awarding of the degree of Doctor of Business Administration.

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DEDICATION

It is with profound affection and gratitude that this dissertation is dedicated to my beloved parents Mary Carole and C. Norman Hollingsworth. It is only a result of their sacrifice, support, encouragement, guidance and love that this was ever possible.

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ABSTRACT

AN EXAMINATION OF FIT AND THE USE OF MOBILE DEVICES FOR PERFORMING TASKS

by

Carole L. Hollingsworth

This research seeks to better understand an individual's use of mobile devices and the matching fit between type of mobile device and activity. As mobile devices swiftly progress and alter individuals' ways of interacting with technology, a more comprehensive understanding of how tasks are impacted may help ensure appropriate device selection. The ability for more targeted device selection may increase use and help mobile device users and designers avoid the pitfalls of pre-existing, traditional technology.

Building on identified antecedents of success from the DeLone & McLean Information Systems Success Model and focusing on the measurement of hedonic and utilitarian tasks and Goodhue & Thompson's Task-Technology Fit Model, the study was applied against four defined categories of mobile devices. The primary study used a survey to test a research model which examines task-technology fit in the context of mobile devices. A secondary feasibility study employed neurophysiological tools with a

focused experiment to explore the impact of the technology and the nature of the task on fit.

At present, this is one of the first studies that attempts to manipulate *both* task and technology in a study of fit yielding results for practitioner and researcher alike. Specifically, researchers will gain additional insight into users' engagement with smartphones, tablets and mini-tablets for hedonic and utilitarian tasks. For practitioners, this study hopes to inform them of the types of tasks users are performing regularly and types of devices are being used. This work may assist in forming future device technical designs and specifications.

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CHAPTER 1

Introduction

Over recent years, technological advancements have driven the digital convergence of technology, computing, entertainment and communications. As technological capabilities have evolved, so too has the use of personal mobile devices. It was projected that by the end of 2014, mobile phone subscriptions would be nearly 7 billion at 6.8 billion, approaching the world's population of 7.1 billion and nearly 40% of the world's population uses the Internet (International Telecommunications Union, 2014). At that rate, by the end of 2015 there will be more active mobile phones than people on the planet. The year 2013 may one day be remembered as "the year of the mobile device" as it was the beginning of this trend and since the year also marked the introduction of new wearable technologies such as Google Glass and Samsung Gear. There have been ongoing trends with additional further refinements and evolutionary updates to many smartphones, tablets and mini-tablets continuing ever since. In January 2015, the International Consumer Electronics Show in Las Vegas was dominated with new wearable technologies and additional mobile devices proving that this trend is continuing (CES, 2015) and this follows a strong year for mobile technologies in 2014 (CES, 2014).

According to the Pew Internet Research Center, 56% of Americans have a smartphone (Smith, 2013b), 28% of cell phone owners used their device in a store to look up reviews of the product and 27% used their device while inside a store to look for a better price elsewhere (Smith, 2013a). Nearly doubling over the previous year, a third of Americans own a tablet computer (Zickhur, 2013). According to Strategy Analytics, a global research and analytics firm, an estimated 990 million smartphones were shipped globally in 2013 alone, with Samsung and Apple making up nearly half of the devices sold (Hyers, 2014). In the fourth quarter of 2013, Apple sold 51 million iPhones and 26 million iPads (Apple Corporation, 2014). Samsung shipped more than 319 million smartphones in 2013 a new record for a smartphone vendor within a year (Hyers, 2014). As these trends are growing, so too is the prevalence of mobile devices and the need for researchers and designers to better understand their use.

Background

Consumers of all ages use and depend on mobile devices more than ever. Consumers are actively choosing to engage with mobile devices to perform tasks beyond simply making telephone calls. These devices are also used for e-mail, short messaging system (SMS) texting, accessing the Internet, calendars, directions and maps or playing games, among other activities. Users rely on these devices by trusting the technology to perform as specified to meet his/her expectations, when the user obtains enjoyment while performing mundane tasks. Even though consumers are using the mobile devices to perform specific activities, much could be learned by examining if the mobile device itself is appropriate for the tasks that are being performed. Simplified, just because the device can be used does not necessarily mean that it should. This work intended to better measure consumer mobile device use for specific task types. To further clarify, both mobile devices and task types need to be defined in the scope of this work.

To take advantage of new mobile device technologies, users share personal information, sometimes without realizing it, yet users enjoy the benefits of these new capabilities. That being said, sometimes the use of new technology requires a consumer to somewhat blindly take a leap of faith by trusting in the device, the system, and the solution the device and software offers. Many users hope that they can trust the technology and they will be safe while using it, while others take a more reserved approach and wait until technology is more proven or universally accepted. Mobile banking has been also on the rise with 35% of Americans using their cell phone to check balances or do other activities online (Fox, 2013). Since 2013, the news was often filled with information about secretive external data collection, large scale security breaches and system failures, most notably involving Edward Snowden, the National Security Agency Prism whistleblower (Greenberg, 2013),the Target credit/debit card breach (Fairchild, 2013) and most recently, the Anthem/Blue Cross data breach (Mathews & Yadron, 2015). As a result, there is increased concern with issues of privacy, data ownership, security and adequacy of the technology. Yet, consumers are still using mobile devices for more activities. These concerns are in addition to others which continue to develop as mobile device use increases, and consumers willingly adopt these new technologies for use in their daily lives.

With the continued technological innovations in mobile devices, increasingly sophisticated applications for these devices, mobile device usage and development is likely to continue increasing over the coming years making a deeper understanding of their use an interesting subject to investigate. Mobile devices are becoming more pervasive in everyday life, and there is a need to better understand their use in order to better direct research opportunities, predict consumer usage and device design. Mobile devices continue to evolve from being optional status accessories to mandatory personal communications and lifestyle tools. Related research is necessary as devices continue to advance and as more can be learned from users' preferences and habits.

Defining Mobile Devices

Currently, there is no comprehensive taxonomy of mobile devices in the literature which is inclusive to categorize current and future portable, wearable and implantable mobile devices. Rawolle and Hess (2000) developed a taxonomy of digital media devices which when modified became the basis for a mobile device taxonomy that grouped devices as mobile portable, mobile transportable and stationary wireless (Feldmann, 2005). However, current wearable technology or implanted devices cannot be adequately represented. Additional taxonomies in this area have focused on mobile applications more than the devices themselves (Nickerson, Varshney, Muntermann & Isaac, 2007). Traditionally, mobile devices have been limited to smartphones, telephones and tablets. For this research, a framework will be offered to classify mobile devices based on attributes.

Mobile devices fit into the arena of ubiquitous computing, are portable and are usually with the user. In addition to portability, aspects of accessibility, reachability, localization and identification are needed for mobile devices (Junglas & Watson, 2006). Accessibility refers to the ease and ability to access a network such as the Internet while identification refers to the finding of a user on a network which contrasts with reachability meaning that the user can be reached at any given time and finally localization means that the experience is modified based on where the user is while using the device (Junglas & Watson, 2006). Additionally, the devices need to be usable in that their interface is functional and supports the intended purpose (Venkatesh, Ramesh & Massey, 2003). Lacking a comprehensive taxonomy to follow, in this study, mobile devices will further be subcategorized as wearable or non-wearable. Google Glass, Samsung Gear and the Apple Watch watches are examples of devices that would be classified as wearable. Examples of non-wearable devices would include a tablet, smartphone, e-reader and other like devices and will be further differentiated by additional capabilities. Chapter 2 includes the framework followed in this work that places mobile devices in one of four main categories – smartphone, tablet, mini-tablet and wearable.

Hedonic and Utilitarian Activities

By definition, an activity that is hedonic is an experience which is characterized by pleasure (Hedonic, 2014). Examples in the real world can include spending time with a loved one, playing with pets, travelling or indulging in a favorite desert. With a mobile device, hedonic activities can include playing a game for one person or for another it might be searching an Internet store for the perfect new pair of shoes. Hedonic activities may differ by person as to what they perceive to be enjoyable. The point is for an activity to be considered hedonic; the user likely is enjoying the activity.

Contrastingly, a utilitarian activity is one what is characterized to be useful rather than decorative (Utilitarian, 2014). In other words, utilitarian activities have practical uses. A few common utilitarian activities that come to mind include taking out the trash, mowing the lawn, doing the dishes or washing the laundry. Although some may derive enjoyment from these activities, for many, these are activities that have to be done but are not necessarily enjoyable.

On a mobile device and in information systems in general, e-mail is often viewed as a utilitarian activity while playing games are viewed as hedonic activities. Van der Heijden (2004) examined user acceptance of utilitarian information systems versus hedonic information systems where the former were productivity-oriented and the latter were pleasure oriented. This will be discussed further in Chapter 2.

Research Purpose

The purpose of this research study was *to measure the impact of technology trust, enjoyment and expectations on a consumer's use of mobile devices and to examine if users are more or less likely to engage in specific activities based on the type of devices used for different types of tasks*. Further simplified, this study examined how fit is affected if the task being performed is defined as utilitarian versus hedonic. The study sought to understand how fit is affected for a utilitarian or hedonic task if the mobile device is changed to a different category.

There is value to the information systems field in that this has not been previously examined in the context of mobile devices to the extent of the experiment being employed. Additionally, this research was one of the first that attempts to manipulate both task and technology in a study of task-technology fit. To clarify, as part of the study, tasks will be held constant across multiple devices and as a secondary measure; different devices will be used to perform different types of tasks thus allowing for the ability to manipulate both task and technology within the study. This work offers a contribution to the field beyond testing in a new context, in that this research tests the theory to understand how task and technology interrelate. Also, there is interest for practitioners as businesses are moving more enterprise applications, such as enterprise resource planning (ERP) or customer relationship management (CRM) systems to mobile devices for in-field use.

This study can help understand the nature of tasks which are best suited for specific devices based on the impact of the appropriateness of fit. Additionally, this work may assist with helping to decide which types of activities will be successful on a mobile device and which tasks businesses should not evaluate for mobile device use. Contributing beyond the initial purposes, future research can explore the results from the studies will help guide direction for additional work mobile device task fit and neurophysiological measures. A deeper understanding of the differences in fit between incorporating hedonic activities into utilitarian tasks and vice-versa may be gleaned. As mobile technological devices evolve, this work should assist developers in taking advantage of device capabilities for specific task types and on the different device types.

This research traces through the relevant technology acceptance literature but concentrates on aspects of success from the DeLone and McLean Information Success Model (DeLone & McLean, 1992) and specific concepts from the Task-Technology Fit (TTF) Model (Goodhue & Thompson, 1995) and how they relate and impact mobile device use. Supporting this research is the volume of work on technology acceptance which has yielded several models through the years including the Technology Acceptance Model (TAM), (Davis, 1989; Davis, Bagozzi & Warshaw, 1989), its extension as TAM 2 (Venkatesh & Davis, 2000), the updated DeLone & McLean Information Systems Success Model (DeLone & McLean, 2003), the Unified Theory of Acceptance and Use of Technology, (UTAUT), (Venkatesh, Morris, Davis & Davis, 2003), and their variations. These models are presented in chronological order within categories in Chapter 2. Additionally, there is significant research supporting task-technology fit and its application with technology acceptance. Through the integration of the task-technology fit measures with supporting success measures, a comprehensive fit model may be created for mobile devices.

Research Questions

This work examines user's individual engagement with mobile devices in a personal application as opposed to examining the use of such devices within an organization. So, the use is assumed to be voluntary by the user instead of mandatory. This distinction is offered to help frame the scope of this work.

The overarching research question that is addressed is as follows:

What will an examination and better understanding of the role of fit and task types tell researchers about an individual's continued use of different categories of mobile devices?

The specific research questions (RQs) which are addressed in this work are as follows:

RQ1 – What is the impact of technology trust, enjoyment and expectations on an individual's continued use of mobile devices for specific, categorized activities (hedonic/utilitarian)?

RQ2 – Does a specific device or category of device make an individual user more or less likely to engage in specific activities (hedonic/utilitarian)?

This dissertation research used mixed methods to answer these research questions by employing a survey (quantitative analysis) in conjunction with, a focused experiment with follow up questionnaire and/or an interview (qualitative analysis). It focused specifically on types of tasks performed on different categories of mobile devices with the overarching consumer interest regarding technology trust, enjoyment and expectations.

CHAPTER 2

Mobile devices allow users to facilitate communication, collaboration and commerce while being able to move within various locations (Sarker & Wells, 2003). The portability and convenience of these devices have contributed to their widespread use. The popularity of the devices reaches beyond businesspersons and extends to users of all ages and education levels.

Categories of Mobile Devices

For the purposes of this work, four categories have been derived to encompass the mobile devices being examined. The categories were determined by assessing features and common traits of different mobile devices, examining for similarities and differences and then grouping them into broad categories based on the specific traits. The categories are defined as *Smartphone, Mini-Tablet*, *Tablet* and *Wearable*. A preliminary study was conducted with 148 students to confirm these categories for reference in this research (see Appendix 1 for details). Rather than focusing on the brand of a particular device, any clarifications based on recognizable devices or brand names is simply meant to help ensure a user understands.

A *smartphone* is defined here as a mobile portable device that is capable of making telephone calls, accessing the Internet, using specialized applications, sending and receiving text and electronic mail messages and is typically used by one individual. Smartphones also typically have an integrated keyboard and/or a touch based interface.

Selected recent examples of smartphones include Apple's iPhones (http://www.apple.com/iphone/), Samsung's Galaxy series smartphones (http://www.samsung.com/us/showcase/galaxy-smartphones-and-tablets/, Blackberry smartphones (http://us.blackberry.com/smartphones.html), Windows Phones (http://www.windowsphone.com/en-us), HTC's phones (http://www.htc.com/us/smartphones/) and numerous others. These devices range from extremely portable, often fitting into a pocket or purse, with an approximate 4 inch to just under 7 inch diagonal screens.

Mini-Tablets are defined as a mobile portable device that is primarily used for accessing the Internet, using specialized applications, sending and receiving text and electronic mail messages and these devices may be shared between multiple users. These devices may also have a method to communicate telephonically but it is not their primary purpose. These devices are also extremely portable and convenient and usually have screen sizes in the range of more than 7 and less than 9 1/2 inches diagonally. They usually have a flat screen and a touch based interface. Current examples of mini-tablets include Amazon's Kindle Fire HD – 7 inch tablet (http://www.amazon.com/dp/B00CU0NSCU/ref=sa_menu_kdpso), Amazon's Kindle Fire HDX – 8.9 inch tablet (http://www.amazon.com/dp/B00DOPNLJ0/ref=sa_menu_kdpap), Apple's iPad Mini series with Retina display (http://www.apple.com/ipad-mini/), Samsung's Galaxy Tab series - 7.0 and 8.0 inches (http://www.samsung.com/us/mobile/galaxy-tab) and numerous others.

Tablets differ from mini-tablets only in their size. Tablets are primarily used for accessing the Internet, using specialized applications, sending and receiving text and electronic mail messages and these devices may be shared between multiple users. Tablets usually have a flat screen and a touch based interface. These devices may also have a method to communicate telephonically but it is not their primary purpose. Some tablets are also considered as suitable touch based replacements for a traditional laptop computer. Additionally both sizes of tablets often have peripheral add on keyboards or a stylus to offer a different method of input other than just touching the screen. In terms of screen size, a tablet is defined as being larger than 9.5 inches diagonal. Current examples of tablets include Apple’s iPad Air 2 (http://www.apple.com/ipad-air-2/), Samsung’s Galaxy Tab series – greater than 10 inches (http://www.samsung.com/us/mobile/galaxy-tab), Sony’s Xperia Tablet Z (http://store.sony.com/tablets/cat-27-catid-Tablets-eReaders) and Microsoft’s Surface 3 tablet series (http://www.microsoft.com/surface/en-us/products/overview) among numerous others.

The final group, *wearable* is the newest device group which might also be considered the most avant-garde. At present, the primary feature of a wearable device is just that, it is worn by the user, is typically used by one person and at present features may differ based on device capability and present a large opportunity over the coming years for device manufacturers and developers. Currently, several different wearable devices are often described, those being a wrist based watch style device that connects to other products such as Samsung’s Gear (http://www.samsung.com/us/mobile/wearable-tech), the Apple Watch (http://www.apple.com/watch/), Motorola’s Moto 360 watch (https://moto360.motorola.com/) and Google’s Glass (http://www.google.com/glass/start/) which is worn like eyeglasses and has a camera and screen which sit just above eye level of the user. Glass was launched as part of an exploratory test with limited distribution but Google recently ended the explorer pilot of Glass. It will likely be re-launched in the future with contributions and improvements learned as part of the explorer program. Applications and device performance will be critical to the success of wearable devices. The hope is that these devices will become useful for a user and not just a novelty as there are numerous possibilities for additional future applications as development permits. Imagine the possibilities for a student having trouble in school due to dyslexia using an application wearing Google Glass to facilitate reading words. Another possibility would be to provide more personalized health, wellness and medical monitoring of an aging parent or a sick child where a caregiver could receive real time updates via their smart watch device. Many of the new wearable devices are integrating health tracking into their systems, for example: Apple has launched a Health application, Samsung has by integrating a heart monitor within the Galaxy Phones and Motorola's Moto Body application for Moto 360.

There have been numerous mobile devices in the past which have transitioned to obsolescence such as Microsoft's Zune and the Palm operating system and related devices and some may believe that wearable devices will follow suit. The difference now is that mobile devices are permeating daily life and have gained more acceptance than in the past. What has not yet been established is the extent that wearable devices will have in the marketplace and the level of consumer adoption. The 2014 Consumer Electronics Show in Las Vegas (January 7-10, 2014) debuted many new and innovative wearable devices as companies strive to tackle this new category (CES, 2014). The 2015 show continued this theme by being dominated by wearables and other mobile devices (CES, 2015)

Mobile devices, like computer systems, require software, specifically an operating system in order to run. These operating systems differ at times by brand but are currently dominated by the three most popular: Android, Apple’s iOS and Microsoft’s Windows 8. Different versions of the systems have differing names, for example, Jellybean, Honeycomb and Kit Kat are all Android operating systems, the name simply differentiates the version and when it was launched. There are similarities for consumers when using products from one vendor in that the operating system on a smartphone may be similar or the same as the one on their tablets; this is the case with Apple and some Android devices. Similarly, applications are often shared across platforms such as having the same game or calendar application on a tablet and a smartphone. For Windows users, elements of the traditional computer and Surface tablet operating systems have converged for users with Window’s phones. Users have the option to choose devices from the same ecosystem or to mix their experience. Additionally, many users will develop a preference for devices based on a particular brand. This work allows for investigation of user preferences based on their own experiences with any brand of mobile device within the categories and does not seek to impose one brand over another. Fundamentally, each mobile operating system works similarly in that applications have been created to enhance the activities and user experience with the devices.

Theoretical Development

Human-Computer Interaction

In its most basic form, the study of human-computer interaction (HCI) investigates how a user engages with a computer or technological device. Thus, HCI is an area that investigates how the mobile device experience differs from a traditional computer. Using a laptop or desktop computer, an individual interacts with the computer most frequently with a mouse or keyboard and typically remains within a stationary position. Newer computers also integrate a touch-based screen experience where the user can touch the screen, use hand gestures or a supplemental stylus.

The user experience can vary based on the actual device that is being used. For example, in the case of a mini-tablet, a user will typically hold the entire device in one or both hands and then usually will use a touch-based interaction to have the device execute the tasks desired. Size, weight, interface all play a key part in the user experience. Conversely, the conventional use of a desktop computer will not involve a user holding the device while interacting with it thus negating the need to consider all the same aspects of the experience.

A user's interaction will vary while using a traditional desktop or laptop computer versus using a mobile device. This difference in interaction is determined by the interface and engagement differences. At times, many mobile devices are extensions of the user in that they are typically used by one person and are personalized to their specifications. Due to the nature of the interface and the design of mobile devices, the user experience with mobile devices often differs significantly versus the traditional computer experience. One of the areas of interest in HCI is examining the interface on between a user and a device (Benbasat, 2010). Future research has also been suggested to focus on improved understanding of cognition beyond the use of survey analysis alone (Lyytinen, 2010).

Task-Technology Fit

Task-technology fit is a widely used model within information systems and is defined by a technology providing the attributes, or features, that support, or fit the particular requirements of a given task (Goodhue & Thompson, 1995). The concept of fit is most appropriate when discussing mobile devices as convergence allows a user to perform tasks that heretofore were most often completed on a traditional desktop or laptop computer system. Additionally, mobile devices often have software applications which are optimized meaning that they have been simplified for use on a specific device type. Even if the technology capability allows for the activity to be performed on a given device, it may not be the best tool for the application. Examining the intersection of the right technological tool for the task being performed is measured by task-technology fit. Essentially, this concept is an expression of the phrase 'fitness for the purpose intended' which often in business describes a warranty or guarantee. Task-technology fit does not guarantee or offer a warranty for use but it does help predict utilization or use of a technology. It is still possible to have the right technology but have it wrong for the task at hand and vice versa.

Task-technology fit is a model which examines the concepts of utilization and fit. Utilization focused literature measure more of the attitudes and behaviors as antecedents of utilization and the ultimate impact on performance while fit focused literature assumes utilization as a result of adequate task-technology fit or the correct task characteristics combining with the right technology characteristics (Goodhue &Thompson, 1995). The important thing to note here is that utilization is defined as the “behavior of employing the technology in completing tasks” (Goodhue & Thompson, 1995, p. 218). For further clarity, utilization is not a measure of duration of use. In this research, the terms use and utilization are synonymous meaning the technology is being used to complete the tasks. Task characteristics are measured to examine non-routineness and interdependence of activities that turn inputs into outputs while technologies include the tools that are used to complete and assist with tasks (Goodhue & Thompson, 1995). Technology characteristics are the attributes of the tools which users use when carrying out particular tasks and include hardware, software and support services (Goodhue & Thompson, 1995). Task-technology fit is defined as the “degree to which a technology assists an individual in performing his or her portfolio of tasks” (Goodhue & Thompson, 1995, p. 216).

Following in Figure 1 is the Task-Technology Fit model

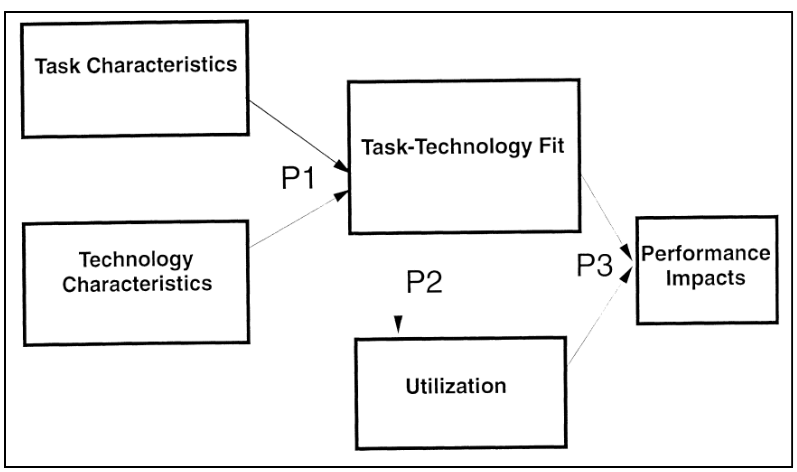


Figure 1: The Task-Technology Fit Model, sourced from Goodhue & Thompson, 1995, Pg. 220.

Here task-technology fit mediates the relationship between either task characteristics or technology characteristics and utilization leading to performance impacts. However, task-technology fit provides a better understanding as to how the technology itself impacts performance and the connections between constructs (Goodhue & Thompson, 1995). In this research, Goodhue and Thompson (1995) brought together two streams of research which focused on performance impacts – utilization approach research and fit focus research.

Figure 2 shows the models as expressed by Goodhue & Thompson (1995).

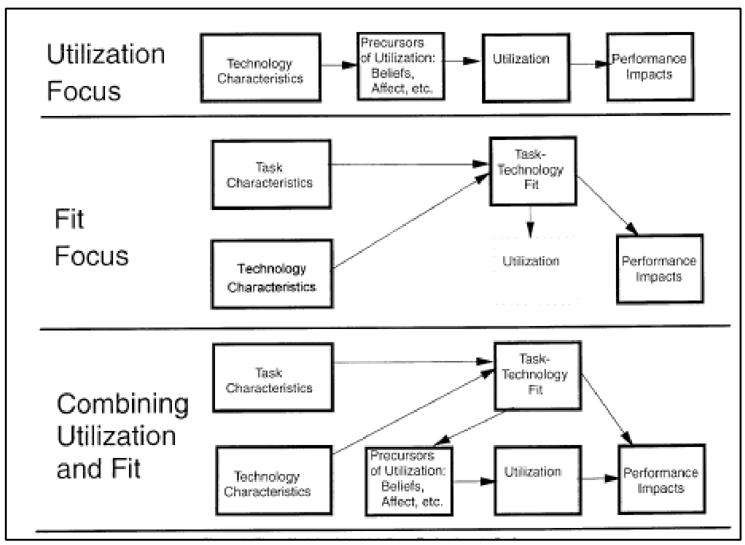


Figure 2: Models featuring Task & Technology Characteristics | Utilization and Fit Focus, Sourced from Goodhue & Thompson, 1995, Pg. 215.

In the exploration of task-technology fit, Goodhue and Thompson (1995) developed a technology to performance chain model in which demonstrates at the individual level, how technology can lead to performance impacts. Specifically, the construct technology characteristics moderates the relationship between task characteristics and task-technology fit and between individual characteristics and task-technology fit. Following in Figure 3 is the Technology to Performance Chain model.

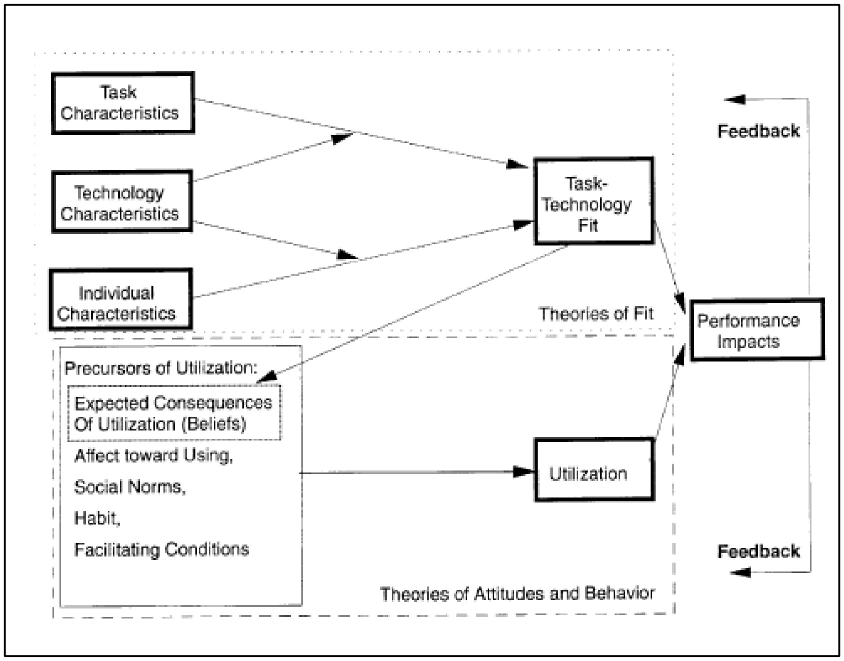


Figure 3: Technology to Performance Chain, Sourced from Goodhue & Thompson, 1995, Pg. 217.

The resulting model when examined for at the individual level is often expressed in terms of a more simplified version where task characteristics are more closely related to task-technology fit but the relationship between them is moderated by technology characteristics leading to individual performance impacts. In various incarnations, since its inception, in 1995, more than 280 conference proceedings and journal papers have used the task-technology fit model. Task-technology fit is a very robust model which is continually examined throughout information systems literature. Although the theory originates in 1995, more than 160 journal articles have been published. Since 2010, nine journal articles have focused on an aspect of mobility including the location of the system as in (Lee, Lee & Kim, 2012; Shih & Chen, 2013) or mobile devices for a specific purpose as in healthcare situations (Hsiao & Chen, 2012; Sheehan, Lee, Rodriguez, Tiase & Schnall, 2012). Prior to 2009, five focused on mobile but this is logical due to the increased capabilities of mobile technologies in general and the trend should be to see more articles focusing on specifics related to mobile technologies of which mobile devices is an aspect. However, none of these articles has examined the role of fit as planned for this dissertation nor added the complexity of the dimensions being measured via quantitative survey and a focused experiment and follow up qualitative questions. To further demonstrate the continued relevance that task-technology fit offers to information systems, Table 1 identifies relevant studies in task-technology fit since its inception.

Table 1: Selected Relevant Task-Technology Fit Literature

Year	Authors	Title	Synopsis
2010 to Present			
2013	Yang, Kang, Oh, and Kim	Are all fits created equal? a nonlinear perspective on task-technology fit	Findings suggest that TTF achievement leads IS use and IT-enabled task performance to their optimum levels
2013	Jain and Kanungo	Realising IT value: Post adoptive IS usage and performance impacts at individual level	Examines performance impacts of IS using task-technology fit and type of IS use at the individual level.
2013	Liang, Ling, Yeh and Lin	Contextual factors and continuance intention of mobile services	Focused on TTF and use of mobile services. Results indicate that a greater level of TTF indicated a higher likelihood of intention to use mobile or application services
2013	Shih and Chen	The study of behavioral intention for mobile commerce: Via integrated model of TAM and TTF	Integration of TAM and TTF in mobile commerce; offered a mobile business model and focused on effects on the medical and insurance industries. Results show the integrated model has higher explanatory power than each model individually.
2012	Liu and Goodhue	Two worlds of trust for potential e-commerce users: Humans as cognitive misers	Examined the impact of trust on a new visitor's intention to return and visit a website again. Recommendations for designers to improve aesthetics, TTF and trustworthiness.

Year	Authors	Title	Synopsis
2012	Sheehan, Lee, Rodriguez, Tiase and Schnall	A comparison of usability factors of four mobile devices for accessing healthcare information by adolescents	Differences in interface quality is examined across mobile devices. Implication is that this is important as a consideration for future mobile device development. Used in conjunction with mHealth applications.
2012	Narman, Holm, Hook, Honeth and Johnson	Using enterprise architecture and technology adoption models to predict application usage	Integration of TAM and TTF. Offers a metamodel that is domain specific to maintenance management usage.
2012	Hsiao and Chen	An investigation on task-technology fit of mobile nursing information systems for nursing performance	Investigates the use of mobile information systems by nurses in a healthcare setting. Suggests that it will offer nursing staff timely and accurate information yielding increased effectiveness and efficiency of nurses in during patient care.
2012	He, Wang and Liu	Empirical research on mobile commerce use: An integrated theory model	Focused on perceptions of fit positively affecting usefulness and security. Additionally, results indicate that perceived value led to intention to adopt m-commerce where. Value is a mediator.
2012	Lee, Lee, and Kim	The impact of task-technology fit on the performance of mobile communication system	Discussed mobile communication systems (MCS) from the context of a task-technology fit framework.

Year	Authors	Title	Synopsis
2012	Lin and Wang	Antecedences to continued intentions of adopting e-learning system in blended learning instruction: A contingency framework based on models of information system success and task-technology fit	Focused examination of task-technology fit and information quality in system acceptance.
2010	Sarker and Valacich	An alternative to methodological individualism: A non-reductionist approach to studying technology adoption by groups	Non-reductionist approach and model providing discussion of technology adoption by groups. Offers some differences where a methodological individualist view offers contrasting explanations.
2010	Sarker, Campbell, Ondrus and Valacich	Mapping the need for mobile collaboration technologies: A fit perspective	Mobile collaboration technologies (MCTs) – provides the ability to map collaboration environments and offers the best practices of the appropriate MCT.
2010	Gebauer, Shaw and Gribbins	Task-technology fit for mobile information systems	Examination of user interface and situations where external factors can be challenging to the design of a mobile information system.
2010	Yen, Wu, Cheng and Huang	Determinants of users' intention to adopt wireless technology: An empirical study by integrating TTF with TAM	Using wireless technology in organizations, intention to adopt it is examined with a model integrating TTF and TAM.
2010	Zhou, Lu and Wang	Integrating TTF and UTAUT to explain mobile banking user adoption	Integration of TTF and UTAUT into a model. This is used to better understand mobile banking adoption by users.

Year	Authors	Title	Synopsis
2000 to 2009			
2009	Cane and McCarthy	Analyzing the factors that affect information systems use: A task-technology fit meta-analysis	Research provides a meta-analysis focusing on task-technology and various research methodologies used in explaining it and its application.
2009	Kacmar, McManus, Duggan, Hale and Hale	Software development methodologies in organizations: Field investigation of use, acceptance, and application	Social exchange, task-technology fit, and technology acceptance are used in a field study of software development methodologies. Perceived usefulness is a positive and strong antecedent to perceptions of fit between the methodology and client problems; strengthening of efficacy beliefs about the methodology.
2009	Larsen, Sørebø and Sørebø	The role of task-technology fit as users' motivation to continue information system use	Extension of Bhatterchjee's Post Acceptance Model (PAM) and TTF. Tested an e-learning tool with college educators.
2009	Fuller and Dennis	Does fit matter? The impact of task-technology fit and appropriation on team performance in repeated tasks	Using fit appropriation model and TTF; offers prediction of team performance based on adoption of technologies. Fit evolves as teams change how they work together.
2009	Junglas, Abraham and Ives	Mobile technology at the frontlines of patient care: Understanding fit and human drives in utilization decisions and performance	Mobile information communication technologies (MICTs) are examined in the realm of healthcare and focuses on nurses engaging in patient care and technology adoption.

Year	Authors	Title	Synopsis
2009	Gebauer and Ginsburg	Exploring the black box of task-technology fit	Applying TTF to the realm of mobile information systems, using an inductive research approach. Voice communication, knowledge work, productivity support, versatility, and design are factors that improve an understanding about the relationship between the identified items and categories for task-technology fit. Results of fit from a multiple regression analysis found that four of the five factors are significant predictors of overall technology evaluation.
2009	Germonprez and Zigurs	Task, technology, and tailoring in communicative action: An in-depth analysis of group communication	Communication analysis using communicative action theory. Examines varying task-technology settings. Study explores group processes, develops and applies group communication analysis tools and enhances theories.
2008	Zigurs and Khazanchi	From profiles to patterns: A new view of task-technology fit	Examines existing theories of fit with collaboration technologies. Proposes new view using patterns.
2008	Junglas, Abraham and Watson	Task-technology fit for mobile locatable information systems	Examined users with mobile technologies that perceive it to be a better solution than traditional means. Employs TTF in a wireless lab experiment. Assigns conditions where the technology is either under-, over-, and ideal fit for the tasks. Using 112 participants, they performed various tasks with locatable technology.
2008	Lin and Huang	Understanding knowledge management system usage antecedents: An integration of social cognitive theory and task-technology fit	Survey of 192 knowledge management systems (KMS) users. The study examined several areas, including self-efficacy which were found to have an impact of KMS usage based on TTF. Research melds TTF and social cognitive theory.

Year	Authors	Title	Synopsis
2007	Barki, Titah and Boffo	Information system use-related activity: An expanded behavioral conceptualization of individual-level information system use	Integrates task-technology fit and activity theory. Examines information systems use at the individual level.
2005	Grossman, Aronson and McCarthy	Does UML make the grade? Insights from the software development community	Research investigates adoption and use of Unified Modeling language (UML) within software development activities. Survey results provided variety of both positive and negative opinions about the use of UML.
2004	Maruping and Agarwal	Managing team interpersonal processes through technology: A Task-technology fit perspective	Investigation of information and communication technologies (ICTs). Uses TTF and media synchronicity theory as applied to teams and individual interpersonal processes.
2004	Staples and Seddon	Testing the technology-to-performance chain model	Tests technology-to-performance chain (TPC) model from TTF. Testing supports the model but may vary if system use is mandatory or optional.
2004	D'Ambra and Wilson	Use of the world wide web for international travel: Integrating the construct of uncertainty in information seeking and the Task-Technology Fit (TTF) model	Model integrates uncertainty in information seeking and TTF into a model. 217 travelers were participants in a survey based study about seeking information on the World Wide Web.
2004	Karimi, Somers and Gupta	Impact of environmental uncertainty and task characteristics on user satisfaction with data	This research offers an examination of environmental uncertainty and task characteristics on user satisfaction. Specifically, environmental uncertainty has been found to have a positive effect on task characteristics.

Year	Authors	Title	Synopsis
2004	Liang and Wei	Introduction to the special issue: Mobile commerce applications	Offers a fit-viability framework that assesses success or failure of m-commerce applications. Specifically focuses on procurement applications and travel agencies.
2004	Gebauer and Shaw	Success factors and impacts of mobile business applications: Results from a mobile e-procurement study	Using task-technology fit, presents a framework and case study. Investigates mobile business applications and success factors. Simple, high functioning mobile applications which support existing information systems are preferred.
2004	D'Ambra and Wilson	Explaining perceived performance of the World Wide Web: Uncertainty and the task-technology fit model	Integrated approach empirically tests uncertainty and the task-technology fit. Presents in a context of WWW usage as an information resource.
2003	Nakatsu and Benbasat	Improving the Explanatory Power of Knowledge-Based Systems: An Investigation of Content and Interface-Based Enhancements	Investigates knowledge-based systems (KBS). Used task-technology fit to examine tasks and performance on problem-solving.
2001	Dennis, Wixom and Vandenberg	Understanding fit and appropriation effects in group support systems via meta-analysis	Presents Fit-Appropriation Model that incorporates TTF and asserts group support systems (GSS) performance is impacted by task fit and GSS structures. Results indicated via the meta-analysis that GSS research results are not inconsistent.

Year	Authors	Title	Synopsis
2001	D'Ambra and Rice	Emerging factors in user evaluation of the World Wide Web	Examined a specifically developed model to address which Web services satisfy information needs that arise outside an organizational-work domain. Identified predictors of performance and technology impact including frequency of use and quality of information available.
2000	Goodhue, Klein and March	User evaluations of IS as surrogates for objective performance	Examines user evaluations of task-technology fit and systems from the perspective of mandatory use as opposed to voluntary use.
2000	Marcolin, Compeau, Munro and Huff	Assessing User Competence: Conceptualization and Measurement	Model assesses, defines and measures user competence. Specifically examines – how what and in what context user competence is evaluated. Results imply that defining and measuring of a user's competence can have an impact, possibly skewing the results.
1995 to 1999			
1999	Dishaw and Strong	Extending the technology acceptance model with task-technology fit constructs	Extension of TAM as an integrated model with TTF to explain software utilization and user performance.
1999	Zigurs, Buckland, Connolly and Wilson	A test of task-technology fit theory for group support systems	Extension and application of task-technology fit to specifically selected group support system experiments.
1998	Dishaw and Strong	Supporting software maintenance with software engineering tools: A Computed task-technology fit analysis	Uses an augmented task-technology fit (TTF) model. Examines use of software engineering tools to support software maintenance for fit, functionality and task requirements.
1998	Zigurs and Buckland	A theory of task/technology fit and group support systems effectiveness	Examines characteristics of a group's task versus group interaction. Puts forth a theory integrating task-technology fit and Group Support Systems (GSS) and their use.

Year	Authors	Title	Synopsis
1998	Dishaw and Strong	Assessing software maintenance tool utilization using task-technology fit and fitness-for-use models	Investigates programmers' choices of software tools for specific tasks. Integrates task-technology fit and fitness-for-use into a model. Questions whether investment in specific tools are producing the expected benefits to the organization.
1998	Goodhue	Development and measurement validity of a task-technology fit instrument for user evaluations of information systems	One of the authors of task-technology fit (TTF) develops an instrument to measure it. Developed from 12 dimensions of TTF, the instrument has reliability and discriminant validity and predictive validity. Offered as an alternative to other instruments but with a focus on TTF allowing for measurement of effectiveness of information systems.
1998	Mathieson and Keil	Beyond the interface: Ease of use and task/technology fit	Determined via a laboratory experiment that an element of TAM, perceived EOU, is also found to be a function of task-technology fit
1997	Goodhue	The model underlying the measurement of the impacts of the IIC on the end-users	Extends initial TTF model, which provided the conceptual basis to assess how end users are affected by the Integrated Information Center (IIC).
1995	Goodhue and Thompson	Task-technology fit and individual performance	The initial research which introduced the TTF as a model and its' role in individual performance. Stresses the importance of the appropriate fit of technologies with a user's tasks to be performed.

User Acceptance of Technology – Review of Relevant Theories

Technology acceptance model. As a cornerstone of information systems, user acceptance of technology is a dominant theme that resonates and permeates the literature. Based on Fishbein and Ajzen's Theory of Reasoned Action (1975) and Ajzen's Theory of Planned Behavior (1991), the Technology Acceptance Model (TAM) offers a parsimonious examination of a user's adoption of technology based on an individual's perceived usefulness and perceived ease of using a given technology (Davis, 1989). At a simple level, TAM sought to better understand why people adopt or accept a technology based on its perceived ease of use and its perceived usefulness. Cited by more than twenty-three thousand articles as of March 2015, the original TAM model remains highly relevant and one of the most used theories in information systems research.

This model can be readily applied to various types of technologies both on an individual and an aggregate business basis. Within information systems, it has been examined often to evaluate technology use. The initial research focused on a two part study testing use of email in a field setting and secondarily in a lab setting evaluating one of two graphics programs (Davis, 1989). Perceived usefulness and perceived ease of use were found to correlate significantly with use indicating that they are good predictors of use. Additionally, a causal relationship between ease of use to usefulness to usage was also found. Both ease of use and usefulness have an impact on predicting use however, it should be noted that the research indicated a stronger relationship between usefulness and use than ease of use and use. This suggests if a technology is useful to a user but not as easy to use, the user may still use the technology since it is useful in performing a task.

In TAM, an individual's behavioral intention to use a technology leads to use. However in this dissertation, study participants will already have experience using the technology so, the need to measure behavioral intention will be unnecessary and actual use, or continued use will be examined as in the final construct within the TAM model. For this work, TAM and its related extensions are not appropriate alone in that there is a need to address success and fit and particularly for mobile devices. Thus, there is a need to create a research model which is much more comprehensive in scope and also focuses on the success of the technology with more in-depth evaluation of the antecedents of success for mobile devices.

Following in Figure 4 is the basic Technology Acceptance Model without extensions.

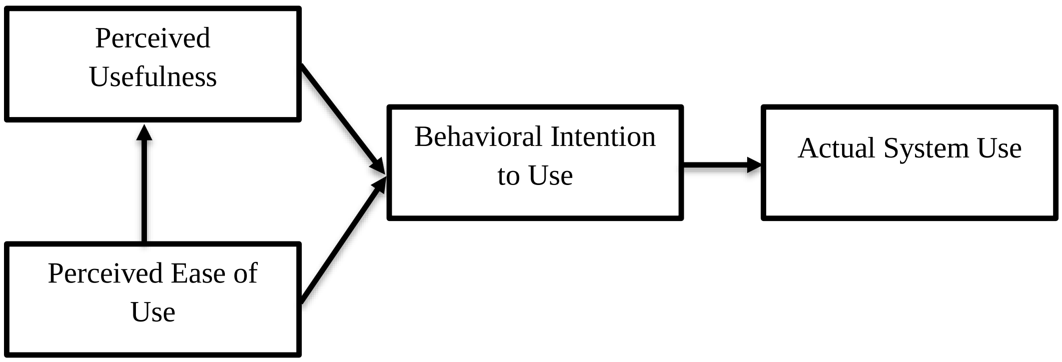
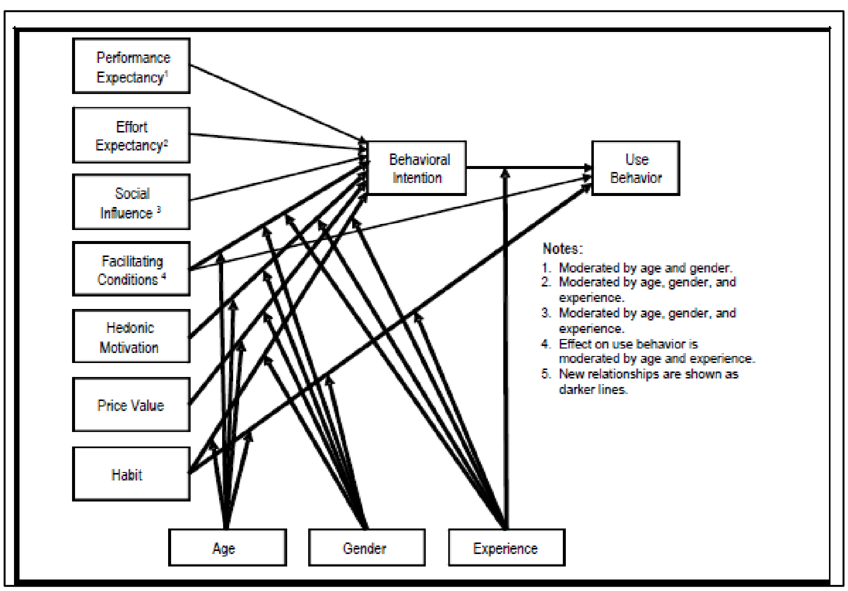


Figure 4: The Technology Acceptance Model, drawn from articles by Davis et al, 1989 and Venkatesh et al 2003.

Unified theory of acceptance and use of technology. A major contribution to technology acceptance literature that is often discussed is the Unified Theory of Acceptance and Use of Technology (UTAUT) which is a comprehensive theory marrying concepts from eight models and extensions to create a unified approach to acceptance and technology use (Venkatesh, Morris, Davis & Davis, 2003). The models which form the basis for this unified work include the Theory of Reasoned Action (Fishbein & Ajzen, 1975), the Technology Acceptance Model (TAM) (Davis, 1989), Motivational Model as applied for information systems (Davis, Bagozzi & Warshaw, 1992), Theory of Planned Behavior (Ajzen, 1991), Combined Technology Acceptance Model and Theory of Planned Behavior (Taylor & Todd, 1995), Model of PC Utilization (Thompson, Higgins & Howell, 1991), Innovation Diffusion Theory (Rogers, 1995), and Social Cognitive Theory (Bandura, 1986). Concepts in this model include performance expectancy, effort expectancy, attitude toward using technology, social influence, facilitating conditions, self-efficacy, anxiety and behavioral intention to use the system (Venkatesh, Morris, Davis & Davis, 2003). This model focuses more on the psychological motivations and social aspects of technology use and is typically presented in the context of use within an organization.

Further extending, with a goal of measuring individual consumer behavior, the Consumer Acceptance and Use of Information Technology (UTAUT 2) examines the moderating relationships of age, gender and experience on behavior and use while incorporating specific measures that affect an individual's decision to use technology those being hedonic motivation, price value and habit (Venkatesh, Thong & Xu, 2012). UTAUT 2 differs from UTAUT specifically with the focus on an individual's use and acceptance of technology which is relevant to this dissertation. Following in Figure 5 is the Consumer



Acceptance and Use of Information Technology (UTAUT 2) model.

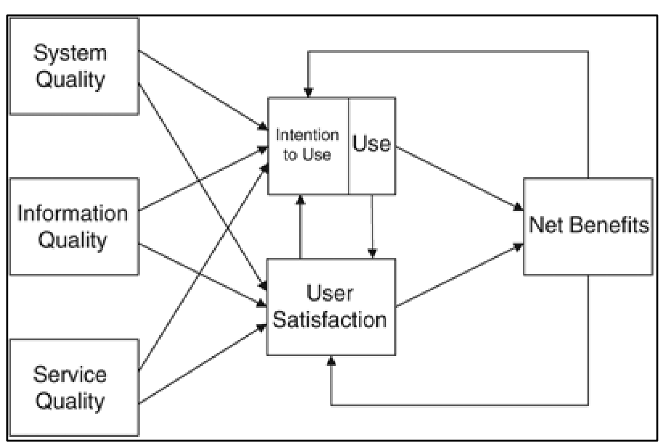
Figure 5: The Consumer Acceptance and Use of Information Technology model (UTAUT 2), sourced from Venkatesh et al, 2012, Pg. 160.

Although the Consumer Acceptance and Use of Information Technology (UTAUT 2) model focuses on the individual, it lacks a measure for technology trust which is necessary as an antecedent of success and use. However, there have been extensions to the model and competing models that better explain more specific technology acceptance and use.

Information systems success model. The DeLone and McLean Information Systems Success Model took the idea of technology acceptance much further and examined six categories of success where it is not merely measured by using a technology versus not using the technology but instead as a net benefit for the individual user and a business (DeLone & McLean, 1992). This source article has been cited 7,575 times (as of March 21, 2015). The article is the most cited article from the top three information systems journals during 1992-2007 further supporting its relevance to information systems research (Lowry, Karuga & Richardson, 2007; Petter, DeLone & McLean, 2013). In the initial model, system quality and information quality are both identified as antecedents of use and satisfaction which in turn lead to individual and organizational impacts (DeLone & McLean, 1992). System quality is defined to include the characteristics desired within a system and is measured by the usefulness of a system's features, the reliability of the system, the convenience of access, system efficiency and ease of use (DeLone & McLean, 1992). Information quality as a construct is defined as a measure of the quality of the system's output. To measure information quality, accuracy, completeness, reliability, currency and uniqueness are some of the areas which are examined (DeLone & McLean, 1992). Each of these areas is highly relevant to examine in the context of mobile device use.

After the launch of the DeLone and McLean Information Systems Success model in 1992, there were numerous efforts to further refine the model and incorporate additional measures of success. DeLone and McLean updated their model and incorporated some of these changes in an updated version of the Information Systems Success Model (DeLone & McLean, 2003). Most notably, are the addition of a much needed component of measurement of service quality and a differentiation between intending to use a system versus actually using a system (DeLone & McLean, 2003; Pitt, Watson & Kavan, 1995). Additionally the individual and organizational impacts were replaced by the construct of net benefits which measures both at an individual and firm level (DeLone & McLean, 2003; Seddon, 1997).

In this study's examination of mobile device use, it is important to understand use at an individual level and thus net benefits are not applicable in an aggregate measure beyond the individual. Following in Figure 6 is the updated DeLone & McLean



Information Systems Success model (DeLone & McLean, 2003).

Figure 6: The Updated DeLone & McLean IS Success Model, sourced from DeLone & McLean, 2003, Pg. 24 and Petter et al, 2013, Pg. 11.

Determinants of Information Systems Success

A comprehensive evaluation of the influence success, in many ways helping to categorize the identified antecedents of success examined more than 600 articles, focused on more than 140 studies and identified 43 specific variables that influence dimensions of information systems success (Petter et al, 2013). From this, these variables were grouped into "five categories based on the Leavitt Diamond of Organizational Change: task characteristics, user characteristics, social characteristics, project characteristics and organizational characteristics" (Petter et al, 2013, pg. 8).

Of these related variables, the three that have been shown to be strong predictors of overall information systems success in the user category and are therefore antecedents are the following: enjoyment, trust and user expectations (Petter et al, 2013).

Measuring these variables is important to understanding success at the user level and will be interesting to explore in the context of mobile devices. Similarly characteristics were examined at the task level and identified determinants which are related to the work activities supporting an organization. Of these, task compatibility was found to be moderately strong at influencing Information Systems Success (Petter et al, 2013).

Table 2 has a comprehensive listing of the identified user characteristics related variables which have been shown to have an impact on success. Also, Table 3 includes the identified task characteristics related variables which have been shown to have an impact on success.

Table 2: User Characteristics - Determinants in IS Success, Excerpted and Sourced from Petter et al, 2013, Pg.16-17.

Characteristic	Description	Related Variables	Variable Description
User	Determinants related to the individuals that use information systems, such as those related to attitudes, personal demographics.	Attitudes toward Technology	The degree to which the user possesses a favorable view about technology.
		Attitudes toward Change	The degree to which the user possesses a favorable view about change, such as technology change or change in general.
		Enjoyment	The level of pleasure or enthusiasm a person has regarding the use of technology.
		Trust	The degree to which the individual has a positive view about the technology in terms of the technology being used in the individual's best interest.
		Computer Anxiety	The degree of fear or concern a user has regarding the use of technology.
		Self-Efficacy	The user's self-confidence about their ability to use the information system or technology in general.
		User Expectations	The degree to which the user's perceptions about the information system are consistent with the actual information system.
		Technology Experience	The amount of past experience a user has had with technology, even if it is a different type of technology than the information system under study.
		Organizational Role	The position of the user within the organization (i.e., worker, manager, secretary, senior executive).

		Education	The degree of education completed by the user of the information system (i.e., some high school, high school, college, graduate degree).
		Age	The age of the user of the information system.
		Gender	The gender of the user (i.e., male or female).
		Organizational Tenure	The length of time the user has been an employee of the firm.

Table 3: Task Characteristics - Determinants in IS Success, Excerpted and Sourced from Petter et al, 2013, Pg.16.

Characteristic	Description	Related Variables	Variable Description
Task	Determinants related to the work activities that support an organization, often supported by IS.	Task compatibility	The fit or consistence between the task and the IS that supports the task.
		Task difficulty	The degree to which the task supported by the IS is challenging to the user.
		Task interdependence	The amount that the task supported by the IS is reliant on other tasks for completion.
		Task significance	The importance of the task within the business process or organization.
		Task variability	The degree of consistency (or lack of consistency) between tasks that an individual completes as part of their interactions with a work process and/or IS.
		Task specificity	The level of clarity of the task supported by the IS.

The Task-Technology fit model is consistent with the DeLone & McLean Information Systems Success model in that both look at user attitude toward technology and then lead to impacts at the individual level (Goodhue & Thompson, 1995). Additionally, performance impact is used as a surrogate for information systems success as it implied improvements in efficiency, effectiveness and quality in the completion of an individual’s tasks (Goodhue & Thompson, 1995; Cane & McCarthy, 2009).

Combining specific aspects of each model and focusing on mobile devices allows this work to investigate more about the role of fit and success on individual use.

Summary. Of the three major streams of technology acceptance literature, the most applicable as a part of the impetus for this research is the updated DeLone and McLean Information Systems Success Model. This will be integrated with task-technology fit to propose a robust model for consumer use with mobile devices for specific tasks. However, instead of examining individual and firm benefits, this research will focus solely on the individual as a user of mobile device technology as opposed to corporate or enterprise use of mobile technology. As a result the individual's decision to use mobile devices is in this work assumed to be voluntary and not mandatory.

Research Model and Hypotheses

Each of these previously discussed models independently offers a chance to examine use of technology. However, to address the specific research questions posed, it is necessary to examine constructs technology and task characteristics to measure potential fit especially when using a mobile device for specific activities. If instead, the technology characteristics and task characteristics are examined together, then the result will be a better understanding of fit. However, each model on their own does not address the idea of success and fit with a specific focus on mobile devices.

There is a need to better understand user preferences and opinions of mobile devices and why some devices may be better suited for specific utilitarian and hedonic activities. As more activities or programs move into online, cloud-based platforms where they can be completed from any location, having the best device to perform the task will be critical for an individual's effectiveness. Researchers and practitioners alike can benefit from information that can be gleaned from individuals that generally already utilize mobile technology and their perspectives of mobile device use.

Research Model

The research model explored in this dissertation is designed to leverage information systems success and technology fit for mobile device use. With a goal of achieving parsimony for a mobile device success and fit model, the seven construct model with a penultimate dependent variable of Consumer Use of Mobile Technology, is offered. The seven constructs are: Consumer Use of Mobile Technology, Task-Technology Fit, Technology Characteristics, Task Characteristics, Enjoyment, Technology Trust and User Expectations. This model focuses on the measuring of specific antecedents of success, enjoyment, trust and user expectations which are inherent in mobile devices and without which consumer use might be hindered or stifled. Although an individual might still use a mobile device to perform a particular task, having the right mobile device for the task will have a positive influence on use of the mobile device for a similar task in the future. For example, there are some tasks which are not suited for a smartphone even though they can be performed, such as using a college learning management system to take an online exam. Different mobile devices offer different user experiences and although the ultimate goal is use, fit strongly affects use.

Following in Figure 7 is the proposed research model.

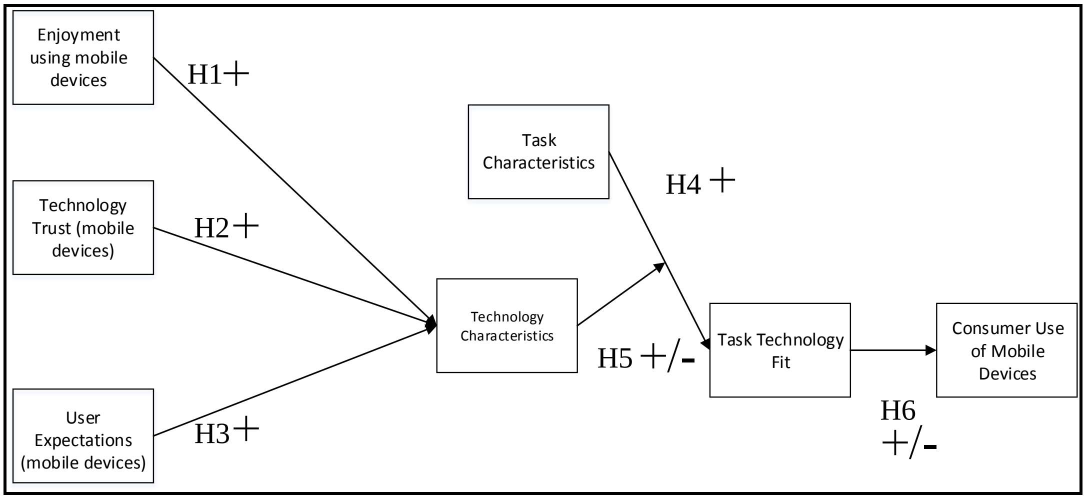


Figure 7: Proposed Research Model

Enjoyment

This construct includes an emotional concept that measures a concept of fun, playfulness and hedonic experiences which are experiences with technology that lead to enjoyment through use. Simply stated for information systems purposes, a hedonic system is one where the value is inside the interaction between the user and a system, such as it is fun to use while a utilitarian system is one where the value is outside the interaction between the user and the system, for example using the system increases productivity (Gerow, Ayyagari, Thatcher & Roth, 2014).

Enjoyment has been defined to be the extent to which using a computer is perceived to be an enjoyable experience without any performance consequence (Davis et al, 1992). Building off that concept, enjoyment has also been measured where the use of the computer is perceived to be enjoyable on its own (Venkatesh, 1999; Venkatesh 2000). Enjoyment as an intrinsic benefit has also been studied (Kim, Chan & Gupta, 2007). Examining hedonic information systems versus traditional utilitarian information systems, perceived enjoyment was found to impact use (Van der Heijden, 2004). As a surrogate for the concept of enjoyment, fun has also been found to be important at influencing use of technology (Bruner, II & Kumar, 2003).

Previously measured as perceived enjoyment and hedonic motivation (Venkatesh et al, 2012), in this research enjoyment is posited as an important part of indicating an individual's propensity to use a mobile device. The user experience with a mobile device is different than a traditional desktop or laptop computer in that the primary method of interfacing with them is via touch or using an integrated keyboard. Enjoyment has also been shown to be an antecedent of system quality and use and has been supported in several studies (Petter et al, 2013).

Wakefield and Whitten (2006) examined enjoyment while focusing on mobile computing use in hedonic and utilitarian contexts. Examining the relationships between perceived enjoyment and perceived ease of use, the results indicated that perceived enjoyment can have an impact on the use of utilitarian systems based on the perceived ease of use (Sun & Zhang, 2006). For this research, enjoyment will be measured by a combination of measures from these two studies: hedonic and utilitarian mobile computing (Wakefield & Whitten, 2006) and perceived enjoyment (Sun & Zhang, 2006).

Since 2010, additional articles have focused on enjoyment with many examining hedonic information systems, utilitarian information systems and combined hedonic and utilitarian information systems. Enjoyment is presently a construct which is being investigated within the discipline in different types of information systems. Table 4 illustrates relevant literature since 2010 measuring enjoyment whether it is perceived enjoyment, actual enjoyment or a specific type such as shopping enjoyment. In several articles, mobile is a key aspect but although none are measuring enjoyment to the specifics of this present study.

Table 4: Articles Measuring Enjoyment Since 2010

System Type	Year	Authors	Type of Enjoyment Investigated *	System Studied
Hedonic	2011	Lai, H. M., & Chen, C. P.	Perceived enjoyment	Teaching blogs in secondary schools
Hedonic	2011	Liu, Y., & Li, H.	Cognitive concentration, perceived enjoyment	Mobile hedonic services/ mobile gaming
Hedonic	2011	Shin, D. H., & Shin, Y. J.	Perceived enjoyment, perceived playfulness and flow	Social network games
Hedonic	2010	Kang, Y. S., & Lee, H.	Perceived enjoyment	Social networking
Hedonic	2010	Mun, H. J., Yun, H., Kim, E. A., Hong, J. Y., & Lee, C. C.	Enjoyment	Digital multimedia broadcasting (with portable media)
Hedonic	2010	Shiau, W. L., & Luo, M. M.	Perceived enjoyment	Blog
Hedonic	2010	Shin, D. H.	Flow, perceived enjoyment	Online role-playing games
Mixed	2010	Kim, B.	Perceived enjoyment	Mobile data service continuance
Mixed	2010	Liu, Y., & Li, H	Perceived enjoyment	Mobile Internet use
Mixed	2010	Lu, Y., Deng, Z., & Wang, B.	Perceived enjoyment	Short messaging service (SMS) in China
Utilitarian	2011	Lee, H. H., & Chang, E.	Perceived enjoyment	Online mass customization attitudes
Utilitarian	2010	Ahn, K., Shim, J. P., & Kim, J.	Enjoyment	Ubiquitous (mobile) tour information
Utilitarian	2010	Hwang, Y.	Enjoyment	E-Commerce (moderating effects of gender)

System Type	Year	Authors	Type of Enjoyment Investigated *	System Studied
Utilitarian	2010	Kamis, A., Stern, T., & Ladik, D. M.	Shopping enjoyment	E-Commerce (flow)
Utilitarian	2010	Lee, S. M., & Chen, L.	Concentration, enjoyment	E-Commerce (flow)
Utilitarian	2010	Luo, X., Gurung, A., & Shim, J. P.	Enjoyment, perceived playfulness	Enterprise instant messaging acceptance

* If other factors are examined beyond enjoyment those are also indicated

H1: High enjoyment of using mobile devices positively influences technology characteristics of mobile devices.

Technology Trust

Trust has been studied for years in conjunction with information systems literature. Notably, Yamagishi developed a trust scale which is often used in multidiscipline research and additionally trust and commitment within the United States and in Japan are examined in strategic research (Yamagishi, 2001; Yamagishi & Yamagishi, 1994). Within information systems literature, trust has been examined in e-commerce use where the reliance on new technology is heavy (Ba & Pavlou, 2002; Gefen, Karahanna, & Straub, 2003; Jarvenpaa, Tractinsky, Saarinen, & Vitale, 2000; Pavlou, 2003; Siau, Sheng & Nah, 2003).

Although trust is studied actively across business disciplines and with great depth, the broad concept of trust is "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other party will perform a particular action" (Mayer, Davis & Schoorman, 1995, p 712). Specifically for this research the type of trust being examined is concentrated instead on technology trust which extends this initial definition to trusting an information system, artifact or mechanical device; this is to refine the focus on the trust in the technology as opposed to on general trust, or trust in individuals. Technological trust is a specific area of trust encompassing an individual's reliance on technologies and remains extremely important for continued use.

Technology trust can be expressed as a user's belief that a technology system will perform a task as expected (Ratnasingham, 2005). Additionally, technology trust has been defined as "the subjective probability by which an organization believes that the underlying technology infrastructure and control mechanisms are capable of facilitating inter-organizational transactions according to its confident expectations" (Ratnasingham & Pavlou, 2004, p. 316). Technology trust has been examined as a complementary construct to interpersonal trust in past research as well leading to purchase intention which also represents use (Li, Rong & Thatcher, 2009). The difference being that the focus of the trust is on the user being able to trust that the mobile device capabilities will in fact work for the purpose intended. For example, a smartphone can be used to make a telephone call. If this technology trust is not present in the devices, then the likelihood of success is quite low.

For this research, technology trust is the focus and the specific technologies being examined from four defined categories of mobile devices. Measurement of trust in the research model, as an antecedent of technology quality and then use, technology will be represented have to function as required for the specific tasks studied. Three expectations users have about technology trust are identified as possessing the functionality to perform a needed task, possessing the ability to provide help when needed, and ability to operate reliably and consistently (McKnight, Carter & Clay, 2009).

Representing the construct of trust in technology, with technology acceptance, measures included willingness to depend on technology and reliability of technology. These measures were found to be antecedents of intention to explore which is a surrogate in this instance to use (Thatcher, Arsal & McKnight, 2004). Trusting in the transaction medium (Pavlou, 2003) represents an extension of trust to the technology used which is relevant for this study. In this case, the transaction medium was using an electronic device for electronic commerce. The extension is examining the use of a mobile device as a transaction medium for specific activities. Some measures for this construct will also be sourced from trust measures for e-commerce which will be specified for mobile devices (McKnight, Choudhury & Kacmar, 2002; Palvia, 2009; Thatcher, Carter, Li, & Rong, 2013). These measures examine technology trust in terms of the reliability and capability of systems and specifically in mobile devices.

H2: Technology trust in the mobile device to perform as intended positively influences technology characteristics of mobile devices.

User Expectations

User expectations reflect the degree to which a user's perceptions of an information system are consistent with the actual experience with the system (Petter et al., 2013). This construct represents the idea that the technology will do what the user expects it to do and how they expect it to do so. This concept has been identified as an antecedent that can predict system use and additionally has a strong relationship with overall information systems success (Petter et al, 2013). This is significant as meeting and exceeding user expectations can lead to positive use and success while not meeting user expectations may not lead to use and may indicate a lack of success. User expectations may also be affected by prior experience with technology and general attitudes toward technology. Generally, a negative attitude toward technology sets up a negative user expectation making it more difficult to overcome. Success is less likely when a negative user expectation and negative attitude toward technology is present.

User expectations have been shown to tie directly to a user's attitudes toward technology in several studies and this construct is strongly supported as an antecedent to use of information systems (Petter et al, 2013). For a mobile device to be successful for specified activities, it will have to meet or exceed any user preconceived notions about the technology. Essentially, a negative attitude toward mobile technology may set up negative user expectations and therefore impact use. Likewise, a positive attitude toward mobile technology may lead to positive user expectations and use. This concept has also been measured as performance expectancy which aligns with the definition of user's expectations of technology performance for this study (Venkatesh et al, 2012).

H3: Perceived user expectations of a device's capabilities to perform specific activities may positively influence technology characteristics for those activities and devices.

Task Characteristics

Task characteristics represent the requirements of the specific task that needs to be completed by the information system (Goodhue & Thompson, 1995). Simply put, the characteristics are those which would be necessary to perform the task while using the technology. In determining information systems success, task compatibility is often measured as task-technology fit within models yet additional measures of task difficulty and task significance are typically examined (Petter et al, 2013).

In order for fit to be achieved, the information system must be able to perform the task required. For example, if a mobile device is not able to perform a specific task based on the technology not being present, then the task characteristics are not met. An illustration of this would be attempting to use a wearable, mobile device such as Google Glass to make a mobile payment using a tap-to-pay station within a business. At present, no functional hardware is included within the Google Glass to perform this function, and therefore the task characteristics are not met by using this device. The changing nature of mobile device development should be noted as additional capabilities are introduced frequently and thus within a span of less than a year, this may prove to be an incorrect illustration of capabilities.

Matching the task required functionality with the appropriate device will lead to task compatibility or task-technology fit (Goodhue & Thompson, 1995; Petter et al, 2013). For this study task characteristics are simply the attributes necessary to complete the task using mobile technology (Liang, Huang, Yeh & Lin, 2007).

H4: The task characteristics for a particular task may positively influence the fit achieved (task-technology fit).

Technology Characteristics

Task-technology fit is a construct which works well with the DeLone and McLean Information Systems Success model in that both measure use and an individual's attitude toward technology (Goodhue & Thompson, 1995). This further supports these concepts being integrated to evaluate success with mobile devices. The technology characteristics construct is being developed here as a surrogate for system quality from the information success literature. System quality is an aspect that needs to be present in a system and positively inclined for the system to be successful. Then combining these aspects with the relevant task characteristics can help achieve the best fit of the device for the specified activity. This construct represents the convergence of the two theories that will lead ultimately to consumer use of a mobile device for specific activities.

Technology characteristics as an appropriate surrogate for system quality. In this model, this construct represents that the system is easy to use and this is a fundamental construct of TAM (Davis, 1989). However, it also goes further to incorporate the usefulness of a system, the ease of learning, accuracy, flexibility and reliability of the system (DeLone & McLean, 1992). System quality is a multifaceted construct which represents more ideas than simply if a system is easy to use. These additional measures help make a predictor of use and success possible.

This research represents the intersection of three significant models in information systems literature. Arguably, each model measures technology quality in different ways yet they are interrelated. Since this research is focusing on the success aspects of mobile device use, the construct is best represented by the measures from the DeLone and McLean Information Systems success model measuring specifically for system quality. Task compatibility has little study previously as being antecedent to these three constructs as it is instead part of the composite construct representing these three concepts (Petter et al, 2013).

Technology characteristics in the context of mobile devices measurement requires analysis of ease of use, usefulness of the system features and functions, system accuracy, response time, reliability adaptability and availability which are measures of system quality (DeLone & McLean,1992; DeLone & McLean, 2003). In addition since the study is focusing on mobile devices, it is expected that response time and accuracy will be key measures within this construct as mobile devices will not be successful if they are not responsive to the user and accurate. Also, technology characteristics will be defined by the ease of use of the mobile device (Sun & Zhang, 2006). Additionally, research has supported that a positive and significant relationship exists between system quality and use (Petter & McLean, 2009). Additionally, a moderating effect of technology characteristics on the relationship between task characteristics and task-technology fit has previously been explored in a mobile experimental context (Junglas et al, 2008) and will also be explored in this study. But the primary reason why the model incorporates the moderating effect is to mirror the initial task-technology fit model (Goodhue & Thompson, 1995).

H5: The technology characteristics used on a mobile device has a moderating effect on the relationship between the requirements (task characteristics) of a specific task and the fit achieved (task-technology fit) where positive technology characteristics has a positive effect and negative technology characteristics has a negative effect on the relationship.

Task-Technology Fit

Task-technology fit can be defined as "the correspondence between task requirements, individual abilities and the functionality of the technology" (Goodhue & Thompson, 1995, p.218). For mobile devices, this will especially hold true when examining functional uses which are new to devices such as mobile payments and banking so as to be more than a novelty.

The concept of fit has been examined in strategic research and defined differing perspectives in a framework with: fit as moderation, fit as mediation, fit as matching, fit as gestalts, fit as profile deviation, and fit as covariation with each having distinctive theoretical meanings (Venkatraman, 1989).

For the concept of fit in this work, examining mobile devices for specific activities, fit as moderation is the best definition and it is the same way task-technology fit has been used in the original model and why it is used here. In simplified terms, the task influences the device selection and technology characteristics moderates the relationship between the two constructs.

Specifically in Table 5, the conceptualizations of each type of fit are further clarified.

Table 5: Conceptualizations of Fit, sourced from Venkatraman, 1989

Type	Explanation
Fit as Moderation	Is an interaction between two variables and this affects another variable (pg. 424)
Fit as Mediation	Is an intervention by one variable between two or more variables (pg. 429)
Fit as Matching	Is a match between two related variables (pg. 430)
Fit as Gestalts	Internal coherence between a set of multiple variables of recurring theoretical concepts (pg. 432)
Fit as Profile Deviation	Level of ability for multiple variables to adhere to an external specific profile (pg. 433-434)
Fit as Covariation	Internal consistency within a set of underlying theoretically related variables, usually four or more (pg. 435-436)

Additionally, in the case of mobile technology, mobility and reachability are important features for assessing fit (Junglas, Abraham & Watson, 2008). Figure 8 displays this extension to task-technology fit integrating mobility and locatability which simplifies the model and again describes a relationship between task characteristics and task-technology fit which is moderated by technology characteristics.

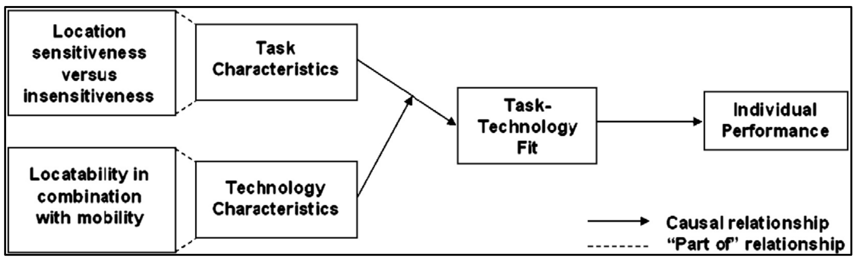


Figure 8: Extension of Task-Technology Fit Model, Sourced from Junglas et al., 2008, Pg. 1049.

The Junglas et al, (2008) study employed an experiment using mobile devices where users were given tasks to complete with varying degrees of fit with an examination of mobility and locatability. One of the findings was that ideal fit conditions outperform under-fit conditions yet over-fit conditions did not outperform ideal-fit conditions leading the authors to infer that users determined that the technology sufficiently met their needs to perform the required task (Junglas et al, 2008) Mobility and locatability were key to this study and are present in mobile devices making an a deeper understanding relevant and through a better understanding of fit, designers can create devices which are better suited for specific task use. Junglas et al, includes the Measures for this work encompass four dimensions and aspects of task-technology fit. Specifically, these originate in the areas of work compatibility (Moore & Benbasat, 1991), ease of use (Doll & Torkzadeh, 1988), ease of learning (Davis 1989) and information quality (Doll & Torkzadeh, 1988).

H6: Positive or negative task-technology fit has an impact on an individual's decision to use a mobile device for specific activities.

Consumer Use of Mobile Devices

The penultimate exogenous variable in this model is Consumer Use of Mobile Devices. Since this research focuses on use of mobile devices for specific activities, this variable represents a surrogate for use or utilization of the categorized devices in conjunction with activities that are part of the survey and experiment. Use of a categorized mobile device is the ultimate goal however, that will be tempered by having the right device for a task through an achievement of fit. Most often in technology acceptance literature, the concept of use is the dependent variable. Some models explore the concept further as in the DeLone and McLean Information Systems Success Model which examines user satisfaction and the individual and firm level combined net benefits. However, for the purpose of this study the focus of success will be on actual use by an individual and understanding how the device can lead to or detract from his/her use.

This construct represents actual use or utilization but not intention to use, which is often used as an acceptable surrogate for use and is pervasive throughout information systems literature. Here the construct Consumer Use of Mobile Devices represents the use one of the devices in the identified categories (smartphone, mini-tablet, tablet, wearable) a minimum of one time and study participants will be queried as to their use of mobile devices. In this study, there is no differentiation made for ongoing use versus a single instance of use. As a result, use and utilization are treated as the same concept. For clarification, single use is defined as a solitary, one-time use of the device and long-term use is defined as multiple uses of a mobile device over a period of time. Previous research has focused on mobile handheld device use and adoption making a distinction between a single use and long term use of mobile devices (Sarker & Wells, 2003). Additional literature in information systems focuses on the distinction between use and continued use (Bhatterachjee, 2001). Although, use has been measured for a single instance by intention to use previously (Sun & Zhang, 2006, Van der Heijden, 2004, & Venkatesh & Davis, 2000) in this work, actual use or anticipated continued use (Bhatterachjee, 2001) is the measure which will be explored.

Following in Table 6 is a listing of the hypotheses. Additionally, in the coming chapter, is a discussion of the methods which are proposed for this study.

Table 6: Summary of Hypotheses

H#	Hypothesis
H1	High enjoyment of using mobile devices positively influences technological characteristics of mobile devices.
H2	Technology trust in the mobile device to perform as intended positively influences technology characteristics of mobile devices.
H3	Perceived user expectations of a device's capabilities to perform specific activities may positively influence technology characteristics for those activities and devices.
H4	The task characteristics for a particular task may positively influence the fit achieved (task-technology fit).
H5	The technology characteristics used on a mobile device has a moderating effect on the relationship between the requirements (task characteristics) of a specific task and the fit achieved (task-technology fit) where positive system quality has a positive effect and negative system quality has a negative effect on the relationship.
H6	Positive or negative task-technology fit has an impact on individual's decision to use a mobile device for specific activities.

CHAPTER 3

The research data collected for this dissertation occurred via two studies. A mixed methods approach is ideal in information systems as the combination of quantitative and qualitative research allows for high value contribution to the field and to practice that are not always sufficient with one method alone (Venkatesh, Brown & Bala, 2013). The primary study examined the research model via a survey. A secondary study, explored the inner workings of task-technology fit to understand how the theory relates to mobile devices and the tasks performed on those devices. The secondary focused experiment employed neurophysiological tools with a focused experiment while asking a participant to complete several tasks using categorized mobile devices. Following the activity, the participant completed a questionnaire about the activity.

Primary Study: Survey

This survey was used to test the seven hypotheses in the research model. Each construct was measured using previously validated items which have been modified for mobile device use.

Research Sample

The targeted sample group members that were applicable for this study are users of mobile devices. Specifically, the studies were conducted in conjunction with a large comprehensive university in the southeastern United States. The study participants primarily included undergraduate students. Participants received an electronic link inviting them to participate in the study. This is detailed further in the upcoming Data Collection section. Undergraduate and graduate students are the dominant profile of participants which is consistent with prior research that uses students for studies of new technological devices, applications and tools (Gordon et al, 1986). Previous studies have shown that there are no major differences between using students as participants versus professionals depending on the nature of the study (Gordon et al, 1986). Additionally, this research focuses on the individual and his/her use of these categorized mobile devices. One-third of Americans over the age of 18 owns a tablet computer (Zickhur, 2013) and smartphone users aged 18-24 and 25-34 represent the two highest concentrations of smartphone ownership (Smith, 2013b). Incorporating students is further supported for this study as they are users of the mobile device technology being investigated. As users of mobile devices, these targeted participants meet the minimum requirements for this study in that the user has some experience with mobile devices as defined for this study. The use of technologies in this study does not require specialized collegiate education. Based on the initial measures for the survey, it would have required approximately 150-300 participants in order to obtain adequate data for measurement ensuring that there would be enough completed surveys. With PLS-SEM, a rule of thumb is ten times the maximum number of arrowheads pointing at a construct either the measurement model or formative construct (Hair, Hult, Ringle & Sarstedt, 2014; Ringle, Sarstedt & Straub, 2012). Following this, the initial items in the survey to represent the model had twelve items in one construct requiring a sample size of 120. To allow for adequate sampling and to account for any potential missing data issues a minimum sample size of 150 was planned based on the current items. Within PLS-SEM, a sample size of 100 is often sufficient to achieve satisfactory level of statistical power. PLS achieves higher statistical power than CB-SEM (e.g., midsized model with weak effect sizes. For example, PLS requires a sample size of 250 versus 1000 in CB-SEM for power of 0.80 (Hair et al 2013).

Measures. The items in the survey are derived from previously validated constructs and are geared to understanding more about the user's experience and opinions on mobile devices and their use. These items were modified specifically for mobile device activities using a combination of questions adapted from existing measures. This was handled on a construct-by-construct basis and adaptations were made to support questioning user experience specifically with mobile devices and mobile device technology. Many of the constructs being measured have established questions within technology acceptance and task-technology fit literature. Some more established measures may have fewer questions to capture user responses adequately. In addition, some demographic information, age, gender and experience with technology were also measured. Appendix 2 contains the initial complete survey, scales and sources. The necessity of the items was determined through a pilot test.

Table 7 summarizes the sources for the initial measures for the survey.

Table 7: Initial Measure Sources by Construct

Construct	Measure Source(s)
Consumer Use of Mobile Devices	Bhattacherjee, 2001 Venkatesh, Thong & Xu, 2012

Construct	Measure Source(s)
Task-Technology Fit	Staples & Seddon, 2004 (also sourced from Davis, 1989, Doll & Torkzadeh, 1988, and Moore & Benbasat, 1991)
Technology Characteristics	Sun & Zhang, 2006
Task Characteristics	Liang, Huang, Yeh & Lin, 2007
Enjoyment	Sun & Zhang, 2006 Wakefield & Whitten, 2006
Trust	Palvia, 2009 (adapted from McKnight, Choudhury & Kacmar, 2002) Thatcher, Carter, Li & Rong, 2013
User Expectations	Venkatesh, Thong & Xu, 2012
General (Demographic, & Self-Efficacy)	Compeau & Higgins, 1995 Jarvenpaa, Tractinsky, Saarinen, & Vitale, 1999 Venkatesh, Thong & Xu, 2012

In addition to the specific constructs previously mentioned, age, gender and self-reported experience with technology were measured. These were identified and sourced from the literature and from user characteristics in Information Systems Success as in Table 2. Many related variables are being examined. It was hypothesized that these areas may have an influence on an individual's behavior to use a mobile device yet the full nature of the effect is not yet known. An individual's self-report of his/her degree of experience with technology is an important concept to examine which has been previously studied in the context of business process, user self-efficacy, computer literacy and software knowledge (Compeau & Higgins, 1995; Goodhue & Thompson 1995; Sedera & Dey, 2008).

User-expressed attitudes toward computer use was measured (Jarvenpaa et al, 1999). User defined experience with mobile devices (Venkatesh et al, 2012) was also been adapted. Additional data was collected to help form a general cognitive assessment.

Data collection. Survey data was collected and captured using the online survey collection tool, Qualtrics. This survey was designed to be accessible from a desktop or laptop computer however, whenever possible, survey participants were encouraged to complete the survey via a mobile device such as a tablet or mini-tablet however there were some who completed it via smartphone. Paper surveys were not administered. The use of an online survey collection tool was an ideal fit for this study as Qualtrics does have survey capabilities for mobile devices within the research tools should the users be able to use one instead of a traditional computer.

Data analysis. Data analysis of the survey was be conducted using partial least squares structural equations modeling (PLS-SEM) approach and specifically using the SmartPLS software program (version 2.0), (Ringle, Wende & Will, 2005). Information systems is a discipline that appreciates the use of structured equations modelling in research and for this study partial least squares is an appropriate method for analysis. PLS-SEM has been actively used in MIS Quarterly in more than 109 journal articles (Gefen, Rigdon & Straub, 2011) and additionally in other leading, respected information systems journals. Although there have been active discussions within the field, as in those advocating PLS use over covariance based structural equations modeling (CB-SEM) such as (Gefen et al., 2011; Henseler & Chin, 2010; Henseler, Fassot, Dijkstra and Wilson, 2012; and Marcoulides, Chin & Saunders, 2009) and those who do not (Goodhue, Lewis & Thompson, 2012a; Goodhue, Lewis & Thompson, 2012b; Goodhue, Thompson & Lewis, 2013). The primary reason for selecting this method for analyzing the survey is due to appropriateness for exploratory research (Hair et al, 2011).

Formal evaluation of the model will include examination of internal consistency, indicator reliability, convergent and discriminant validity as well as predictive relevance and heterogeneity (Hair et al, 2013; Hair, Black, Babin & Anderson, 2010; Urbach & Ahlemann, 2010).

Internal Consistency. The model will be tested for internal consistency by measuring Cronbach's alpha (α). Following established guidelines, values will be analyzed and should not be greater than .9 (Hair et al, 2010). This number will increase with the number of indicators and assumes that all indicators are related to the construct. Composite reliability (ρ_c) will also be examined following the same guidelines as Chronbach's α.

Indicator Reliability. Indicator reliability requires that at least 50% of each indicators variance be accounted for by the underlying construct and this can be measured by examining the results of the outer loadings (Hair et al, 2013). Outer loadings need to be larger than .7 and this is also known as indicator communality.

Convergent Validity. Measures for convergent validity includes the average variance extracted (AVE). Here each construct should account for at least 50% of the indicator's variance (Hair et al, 2010). This is also referred to as construct communality.

Discriminant Validity. Discriminant validity is assessed by examining the Fornell-Larcker criterion which specifies that the square root of the AVE must be greater than the correlation of the construct with all other constructs in the structural model (Fornell & Larcker, 1981). This is reported in the correlation matrix with the square root of the AVEs on the diagonal. Fornell-Larcker is appropriate in this model as the measures are reflective and not formative and no constructs are measured by single items

(Hair et al, 2013). Additionally, the each indicator should load highest on the construct it is associated with. Without these, there would not be divergent validity. Additionally, these results are included in a matrix in Chapter 4 Results.

Analysis of Structural Model. The structural model is assessed for collinearity by examining tolerance and VIF values assessing each part of the model in predictor subsets (Cassel, Hackl & Westlund, 1999; Hair et al, 2013). Next, significance and path coefficients will be investigated for direct, indirect and total effects by using bootstrapping. Coefficient of determination (R^2) will be used to measure the model's predictive accuracy and represents the amount of variance in the exogenous constructs that is explained by all of the endogenous constructs which are linked to it (Hair et al, 2010). The value should be high enough to indicate minimal explanatory power and higher values are preferred (Urbach & Ahlemann, 2010). Effect size f^2 is examined to determine how strongly the exogenous construct contributes to explaining an endogenous construct in terms of R^2. This is accomplished by using blindfolding (Hair et al, 2013). Additionally, goodness of fit is examined (Henesler & Sarstedt, 2013). All final analyses are discussed in detail in Chapter 4 Results.

Primary Study: Survey Pre-Test and Pilot Tests

Preliminary Testing

Pre-Test. Using Qualtrics for data collection, the initial items selected for the survey were tested by 8 individuals. A list of the initial items is found in Appendix 2. Twelve individuals received the survey and started it but only eight completed it within the testing period of availability. Of the final eight who completed the pre-test, six of the participants were doctoral students in Accounting, Management and Marketing and the final two participants are active researchers in IS. The goal was to use individuals who mostly were unfamiliar with the types of items present in this survey but to also use persons with experience with differing types of mobile devices. The primary purpose of this pre-test was to ensure there were no wording issues or items which might be confusing to survey participants. From this, several items were adjusted in terms of color and or bolding and the font sizes were also changed to be larger. Page breaks were added to limit the survey to be four to five questions per screen thus preventing a need for scrolling up and down. Finally, a progress bar was added to allow users the ability to know where they were in the process. Next, the survey was deemed ready to launch in a pilot test.

Pilot Test 1. An initial pilot test was administered using the survey and collected via Qualtrics. This group of participants was comprised of junior and senior IS major students within the same required major course. Some were in their first upper division major course and several were in their final semester. All participants were active users of mobile device technologies. Initial analyses of the results yielded significant issues with reliability and validity. All initial items focused on mobile devices as an aggregate category representing smartphones, mini-tablets, tablets and wearables. An exploratory factor analysis was performed where the data was tested using principal components, varimax rotation and seeking Eigenvalues greater than 1 (Hair et al, 2010). Additionally, the items were measured using the Kasier-Meyer-Olkin (KMO) measure of sampling adequacy, Cronbach's Alpha (α), factor loadings, total variance explained, rotated component matrices and communalities for each item following best practices (Hair et al, 2010). However, the results yielded several areas where items were significantly cross loading or were poor measures of the intended constructs yielding finished results of the exploratory factor analysis to be unacceptable. Several items were removed immediately and/or replaced however, further discussion and analysis suggests that using mobile devices as a general term to represent multiple categories was a substantial contributor to the problems. It was also determined that several items were causing confusion between constructs. As a result, additional items were sourced and the determination was to undertake a second pilot test to resolve these issues. Items that were designed to measure constructs were examined and several were replaced. Specifically, EN4, EN5, TR1, TR6, TR7, TR8, UE1, TTF5, TTF6, TTF7, TTF8, CU1, CU2 and CU3 were all removed from the original survey. EN1, EN2, EN3, TR9, TR10, TAC1, TAC2, TAC3, TTF3, TTF4, BI1, BI2 and BI3 were modified and replaced in the survey. Appendix 3 details a complete listing of the final survey. Additionally, in an attempt to focus the participants' thinking on a particular category of mobile devices, the second pilot asked questions about smartphones only. The goal was that this and the new items would ameliorate the reliability, validity and cross-loading issues, then additional steps would be taken to gather the information about other types of mobile devices. These changes necessitated the need to conduct a second pilot test to finalize the survey.

Card Sort. Before proceeding to Pilot Test 2, a card sort was performed. Six persons were selected at random to participate. Two were college professors who do not actively research, the other four were randomly selected students from a convenient sample within a particular class. Each item was put onto its own white index card. Participants were given the entire stack, which asked about users and smartphones, and they were asked to put them into groupings that made logical sense to them. They were not told what the name of the constructs used in this work. Instead, once the card sort participants completed the sort, they were asked to name the groupings. This resulted in a much clearer understanding of the measures. Additionally, it appeared that focusing on smartphones had reduced confusion. There were three items which had been asked in question form and as an outcome from this activity, these were revised to be asked in statement form providing better clarity. Next, Pilot Test 2 was completed.

Pilot Test 2. For Pilot Test 2, the modified survey was delivered using Qualtrics. This group was comprised of a mix of sophomore, junior and senior business major students within the same upper division required IS course. Students were in various stages of their business school career but the majority were second semester sophomores or first semester juniors. These 31 participants were all part of the same asynchronous fully online course. Examining the results, acceptable reliability and validity was achieved and the survey was ready to be rolled out to for full data collection. Also, for the final survey, to help assess smartphones versus other mobile devices, additional items were required. So, the same measures were added to the survey this time focusing on the users' opinions of tablets and mini-tablets. Fundamentally, the only difference between these two categories is the size so gaining users' perceptions would combine those users of each type of tablet. At present, wearables continue to be less prevalent and the same measures were not asked for them. However, additional items capture users' perceptions of those as future devices. The final survey was adjusted and completed in Qualtrics and preparation of the final data collection began.

Pilot Test Results - Exploratory Factor Analysis. Following the pilot test, an exploratory factor analysis was conducted to assess the items used to measure each construct. The pilot data was examined first for principal components, with varimax rotation and with Eigenvalues greater than one. Additionally, Cronbach's Alpha (α), factor loadings, total variance explained, communalities and the rotated components matrix was analyzed. The results included less than desired or acceptable values indicating there may be some issue with the measures. So, first the procedure was redone but this time it was examined for a fixed number of factors. There were still some issues with the results and after some reflection, it became clear that a second pilot test was necessary. Several items were replaced and better, more explicit measures were added to support and differentiate measurement between the several constructs where there had been issues. This process included a card sort procedure which was detailed in Chapter 3. Following pilot test 2, the exploratory factor analysis yielded that identified measures being acceptable in measuring the constructs and the final survey instrument was prepared for administration (Hair et al, 2010). Further, the final survey implementation would also separately collect information about smartphones and then also about tablets/mini-tablets. Analysis of the final data collection is discussed in Chapter 4. Again, a copy of the final survey is in Appendix 3.

Secondary Study: Focused Experiment

Through the secondary study, additional insight into fit was explored by examining fit at a cognitive level addressing opportunities for study which have been identified in information systems research (Davern, Shaft & Te'eni, 2012). This study primarily examined the user's attitudes toward the technology marrying with the tasks that have to be completed via qualitative analysis. Conceived as a feasibility/focused experiment, a participant was asked about performing specific activities and the devices used as part of the focused experiment activity. The focused experiment allowed for additional cognitive behaviors to be recorded with neurophysiological tools to augment the analysis. Prior studies have demonstrated evidence that task-technology fit does affect ease of use regardless of interface when using a database system; this may be translatable to different types of systems (Mathieson & Keil, 1998). Location-based mobile device application services have also been previously examined using an experiment where the ideal fit outperformed under-fit conditions (Junglas et al, 2008).

Hedonic and utilitarian tasks

During the focused experiment activity, the participant performed tasks which are classified as either hedonic or utilitarian in nature. A hedonic task is one which is inherently fun or pleasurable to perform. However, in the case of a hedonic task here it will not be a game but instead something which has aspects which are considered to be fun to complete and is based in the literature. Utilitarian type tasks are much more abundant in business routines and examples of utilitarian tasks are checking and replying to email or using an ERP system. Hedonic information systems and utilitarian systems have previously been examined in that users identify with more with one type or another and incorporating hedonic features into a utilitarian system can be beneficial to gain user acceptance (Van der Heidjen, 2004).

Focused experiment protocol. Neuro-information systems (Neuro-IS) is an extension of HCI and focuses on the use of neurophysiological recording tools to better understand human thought processes to control a computing device (Dimoka, 2010; Riedl, Randolph, vomBrocke, Leger & Dimoka, 2010). The focused experiment phase of this research will help illustrate how tasks completed while using specific devices can activate certain portions of the brain. Conceptually, extending to practice, this was undertaken as a feasibility study which explored a focused experiment participant engaging in hedonic and utilitarian tasks on mobile devices. The goal was to develop a protocol which can be extended for a future study and will serve as a precursor to a conceptual paper or a conference paper. For practitioners, taking this knowledge to a practical application, these tools can be used to better understand an individual's use of mobile devices for enhanced design and improved interaction between the user and the device.

Beyond what we can learn from asking a user directly via a questionnaire or interview, what can we learn from studying the brain activity of participants in an experiment? Neurophysiological techniques can enhance HCI research by augmenting traditional measures with rich, dynamic data (Riedl et al, 2010). For example, functional magnetic resonance imaging (fMRI) has been used to identify the level, duration and location where activity occurs within the brain when studying trust and distrust resulting in the discovery that trust is associated with the reward, prediction and uncertainty areas within the brain (Dimoka, 2010). Additionally in the Dimoka (2010) study, distrust was found to be correlated with the intense emotion and fear of loss areas within the brain thus highlighting that trust and distrust are not opposite constructs. Both ease of use and usefulness are two key components of TAM that have been examined using fMRI while viewing websites (Dimoka & Davis, 2008). This study led to identification of the areas being impacted in the brain allowing the researchers to gain information that supplements surveys from in the study and also depict internal brain processes that are not viewable from surveys alone (Dimoka & Davis, 2008). This present research sought to also glean information from brain activity which is not viewable from surveys alone.

Research opportunities have been identified relating to the individual acceptance and use of information systems. This present research attempted to address one area where system design can be based on utility, friendliness and usability based on neurophysiological data, by examining new determinants of use and hedonic versus utilitarian systems (Dimoka et al, 2012). The research model in this work provides a convergence of a measure of task-technology fit and use focusing on mobile devices thus extending Dimoka et al's call for further research into a focused area of mobile technology study (2012).

The focused experiment investigated more about the nature of specific types of tasks and the types of devices users are willing to use to perform them. For the focused experiment, the participant was purposively sampled as this experiment also aimed to create a template for future experiments which would not seek to skew the data by gender and future participants will be screened for their dominant hand with a preference for those who are right-handed emulating what is common in cognitive psychology studies.

After consenting, the participant came to the Kennesaw State University BrainLab in the Burruss building for their appointment which took approximately an hour for the activity and follow up questionnaire. During the session in the lab, they were be briefed as to how the experiment would progress and what they should expect. They were able to ask any clarifying questions and if they chose at that point to no longer continue, they had the option to opt out of the remainder of the session. The participant did not opt out and even for future studies, it is not expected that participants would choose to no longer participate as there is a high level of interest around research in the lab.

Electroencephalography (EEG) was being used as a cost effective recording tool and less-invasive technique for this study. Functional magnetic resonance imaging studies in general are costly due to the investment in the fMRI scanner and large amount of imaging data to be analyzed by a trained technician (Dimoka, 2010) and at present an MRI machine was not available for this research. Electroencephalography devices from medical science are used to measure electrical brain activity on the scalp (Dimoka et al, 2012). Participants are fitted with a cap with embedded electrodes linking to a bioamplifier for recording EEG. A connected computer system filters and translates activity generated while completing the tasks.

Eye tracking may also be employed in future experiments and as part of the template and is defined as “eye pupil location gaze and movement” (Dimoka et al, 2012, p. 681). This eye gaze data may help better understand where users look while interacting with a mobile device. Such data can assist with triangulating how a user is feeling when interacting with mobile devices and their varying levels of engagement. This data may also offer better understanding of user preferences and expectations with the devices and applications tested. However, there are some limits with technologies. When users require corrective contact lenses or wear glasses, they may not be able to employ the eye tracking devices as it may not be able to validate pupil gaze and movement. When this happens in the lab setting, the primary focus will be using a case study approach to evaluate the results of individual participants.

Within the lab, a participant will be asked to complete a series of hedonic and utilitarian tasks using mobile devices. The participant will be completing the same tasks as a within-subjects design. There were two activities (hedonic and utilitarian) performed across two devices resulting in four observations for the participant. Also, as previously stated, for simplification in the lab setting, the devices are from a single operating system, Apple's iOS.

The purpose of completing the focused experiment activity in addition to the survey is to examine what can be learned from internal brain processes while a user is completing hedonic and utilitarian tasks on mobile devices. Using neurophysiological tools as additional data measures while participants are performing the tasks in the session will generate additional data to complement questionnaire and interview responses. The desired outcome is that the additional data helps to further refine the understanding of fit while using specific mobile devices for specific activities.

Focused experiment follow-up. Conducting a post activity questionnaire is designed to further clarify and gain understanding and additional comments from the study participant. Larger scale future projects could include semi-structured interviews as well. Mixed methods have been used and advocated to provide a complement to other views and to offer a complete picture of the phenomena (Venkatesh et al, 2013). Upon completion of the activity, the participant was questioned about their individual experience and attitudes toward using mobile devices for the tasks that they performed. This is designed to further clarify from them if there are other comments that are not yet captured from the activity. The participant will also be given a chance to offer any other additional comments. They were thanked for their time and participation. Typically, participants in studies involving the neurophysiological tools have viewed activities such as this as novel and interesting and as such volunteer to participate without the need for further compensation.

Data analysis. Data results from this activity will be analyzed using established neuro-analysis best practices. A summary of the findings, observations gleaned and future opportunities will be included in Chapter 4.

CHAPTER 4

This chapter focuses on the results obtained from the primary study – the survey and the secondary study – the focused experiment. These results examine the testing of the research model. As a result of the findings from Pilot Tests 1 and 2, the model will be examined first for smartphones and second for mini-tablets and tablets. Following this will be a discussion of the results from the focused experiment. Following best practices and established IS research standards, the model will be examined for reliability, validity, and measurement.

Quantitative Results

Data Collection

The final survey was delivered to four classes of undergraduate business students taught by two different professors. Two sections were comprised of the entry level required IS course and two sections were comprised of the junior level business core required course. One entry level and one junior level course was taught in the morning and the same was taught in the evening. These students and classes are part of a large comprehensive university in the southeastern United States. Participation in this survey was voluntary and those who participated received 1 point out of 100 on their final course average. The surveys were administered via Qualtrics. Each professor had their own unique link so the data was collected in two groupings. For one professor, the questions about smartphones were delivered first and then were followed by tablets/mini-tablets, then demographic and control items. For the other professor, the tablets/mini-tablets questions were delivered first followed by smartphones, demographic and control items. The mean age of participants in the entry level course is 22.75 years. The mean age of the junior level course participants is 27.08 years. Table 8 reviews the mix of participants in the survey.

Table 8: Mix of survey participants

		Entry Course Comparisons			Junior Course Comparisons			Overall		
	Timeslot / days	N	Male	Female	N	Male	Female	N	Male	Female
Professor 1	Morning	63	32	31	48	32	16	111	64	47
Professor 2	Evening	70	42	28	47	27	20	117	69	48
	Totals	133	74	59	95	59	36	228	133	95
			56%	44%		62%	38%		58%	42%

Comparison of the samples. Each of the 4 classes' data were individually examined separately and then compared. The goal was to learn if the different classes could be pooled for analysis purposes. Using IBM SPSS 22, items were examined using T-Tests. These were performed for Smartphones with each entry class and then a separate set for both junior classes, against all constructs. Following best practices for analysis, the independent samples T-Test was used for each examination (Hair et al, 2011). Following a review of the results and an examination of the Levene's test for equality of variances the appropriate significance column was selected (Hair et al, 2011).

The results were that there were no significant differences between each of the samples. This process was repeated for the Tablets/Mini-Tablets. Here again, no significant differences were found between each of the samples.

Analysis of the Measurement Model

Once final data collection was complete and the data collected was merged together, a confirmatory factor analysis was conducted to assess the items used to measure each construct. In this initial analysis, there were significant issues with one construct in particular - task characteristics. The items were not offering a clear picture of the user's perceptions when answering these questions and therefore providing results which were not fully measuring participants' perceptions. However, additional data had been collected during the survey process which was specific to individual users' experience with performing specific types of tasks on specific types of mobile devices. Specifically, there were three questions which asked about utilitarian tasks, such as using a device to access the school's learning management system and there were three questions which asked about hedonic tasks such as using social media. To weight these activities and create a calculated task score, utilitarian tasks were deemed to be worth -1 each and hedonic tasks were given a worth +1 each. Not all participants identified that they would use each specific device to perform the specific task so there was some variety as to what they were willing to do. The goal was to see how much each participant leaned in either direction. The anticipated task score range would be from -3 to 3 for smartphones and -6 to 6 for tablets/mini-tablets. This difference is due to some answering their preferences on both types of tablet while some may have only answered for their preferred tablet type. To calculate a score for each user, this factor was multiplied times each of the three initial task characteristic items and created new calculated task characteristic items. These new task characteristic items were created for smartphones and for tablets/mini-tablets and it is these calculated variables which are included in analysis. In each following table and subsequent analysis, these calculated TAC items are included for both smartphones and tablets/mini-tablets. Next, to assess internal consistency reliability, factor loadings from PLS were tested. The analysis for each of these was conducted for smartphones and then for tablets/mini-tablets.

Confirmatory Factor Analysis. All constructs had Cronbach's alpha scores which were above .7 which is desirable (Hair et al, 2014; Nunally & Bernstein, 1994). In the pilot testing, task characteristics was within acceptable limits and the study proceeded accordingly. For tablets/mini-tablets, the Cronbach's alpha scores were above .7 for all constructs as well. Creation of a universally applicable model may require other measures especially when wearables are also considered as the tasks may vary greatly with the different types of devices. Table 9 details the Cronbach's alpha values followed by factor loadings for Smartphones and then Table 10 details the same results for Tablets/Mini-Tablets.

Table 9 - PLS Loadings and Cross-Loadings - Smartphones

Smartphones (N=228)	Cronbach's Alpha	Item	1	2	3	4	5	6	7
BI/Use	0.7632	BI1s	0.7946	0.5129	0.0727	0.5523	0.4093	0.5187	0.3539
		BI2s	0.7842	0.6585	0.0653	0.4952	0.5843	0.5543	0.4379
		BI3s	0.8893	0.5856	0.0398	0.6393	0.6248	0.6821	0.5198
Enjoyment	0.7966	EN1s	0.4588	0.6852	0.0820	0.2922	0.3210	0.3042	0.2591
		EN2s	0.6273	0.9188	0.0786	0.5101	0.6139	0.5770	0.5240
		EN3s	0.6873	0.9082	0.0644	0.4639	0.5556	0.5245	0.4203
Task Characteristics	0.9299	SM_TAC1	0.1045	0.0960	0.9683	0.0281	0.0649	0.1940	0.0056
		SM_TAC2	0.0351	0.0768	0.9337	-0.0369	0.0474	0.1087	-0.0239
		SM_TAC3	-0.0133	0.0376	0.8801	-0.0734	0.0055	0.0537	-0.0121
Technology Characteristics	0.8824	TEC1s	0.5358	0.4032	-0.0278	0.8288	0.4867	0.5210	0.3546
		TEC2s	0.6612	0.4721	0.0427	0.8447	0.6884	0.6113	0.5299
		TEC3s	0.5742	0.4140	-0.0072	0.8799	0.5479	0.5239	0.4163
		TEC4s	0.5726	0.4678	-0.0401	0.8838	0.6173	0.6107	0.4469
Technology Trust	0.8778	TR2s	0.5850	0.5176	0.1110	0.5852	0.8375	0.5961	0.4693
		TR3s	0.5813	0.4920	0.0701	0.5950	0.8432	0.6142	0.5451
		TR4s	0.5670	0.5468	-0.0053	0.5648	0.8763	0.5977	0.4984
		TR5s	0.5331	0.5305	0.0070	0.6105	0.8646	0.6045	0.5218
Task Technology Fit	0.7822	TTF1s	0.5840	0.5099	0.1571	0.4998	0.5529	0.8332	0.5143
		TTF3s	0.6590	0.4844	0.1621	0.5712	0.6292	0.8050	0.5099
		TTF4s	0.5401	0.4417	0.0658	0.5856	0.5749	0.8645	0.6172
User Expectations	0.8697	UE2s	0.5403	0.5938	0.0890	0.4669	0.5841	0.5783	0.7229
		UE4s	0.4620	0.3890	-0.0147	0.4693	0.5344	0.5929	0.7549
		UE5s	0.3708	0.2993	-0.0217	0.3790	0.4044	0.4982	0.8862
		UE6s	0.4368	0.3778	-0.0319	0.4089	0.4458	0.4992	0.8481
		UE7s	0.2712	0.2360	-0.0838	0.2838	0.3502	0.4012	0.8313

Table 10 - PLS Loadings and Cross-Loadings - Tablets/Mini-Tablets

Tablets/Mini Tablets (N=127)	Cronbach's Alpha	Item	1	2	3	4	5	6	7
BI/Use	0.7696	BI1t	0.7631	0.7075	-0.0878	0.6969	0.5821	0.5090	0.3674
		BI2t	0.8419	0.5272	-0.0669	0.3640	0.5504	0.6475	0.6311
		BI3t	0.8724	0.5188	-0.0749	0.5453	0.6773	0.6814	0.6171
Enjoyment	0.8318	EN1t	0.5115	0.8084	-0.0392	0.5807	0.3422	0.3741	0.2627
		EN2t	0.6094	0.9156	-0.1376	0.5716	0.5786	0.4830	0.4520
		EN3t	0.6678	0.8712	-0.0846	0.6036	0.6135	0.4760	0.4310
Task Characteristics	0.9452	TB_TAC1	-0.0109	0.0716	0.8395	-0.0010	-0.0294	0.0267	-0.0528
		TB_TAC2	-0.0404	-0.0194	0.9118	-0.0295	-0.0926	-0.0512	-0.1275
		TB_TAC3	-0.0935	-0.0940	0.9819	-0.0535	-0.1145	-0.1021	-0.1782
Technology Characteristics	0.8263	TEC1t	0.4210	0.6472	0.0092	0.7347	0.3243	0.2894	0.1857
		TEC2t	0.6089	0.6738	-0.1996	0.8578	0.6977	0.5202	0.4502
		TEC3t	0.4617	0.3691	0.0943	0.7901	0.4970	0.3795	0.3187
		TEC4t	0.5162	0.4788	-0.0153	0.8539	0.5970	0.4853	0.3951
Technology Trust	0.8352	TR2t	0.5760	0.6989	-0.1645	0.6937	0.7840	0.5052	0.4222
		TR3t	0.6321	0.4028	-0.0745	0.4817	0.8165	0.6529	0.5853
		TR4t	0.6109	0.3749	-0.0746	0.5007	0.8671	0.6798	0.5609
		TR5t	0.5546	0.3476	-0.0659	0.4450	0.7916	0.6206	0.5787
Task Technology Fit	0.7753	TTF1t	0.6100	0.5696	-0.1413	0.3698	0.5156	0.7802	0.6677
		TTF3t	0.7009	0.3741	-0.0396	0.5443	0.7657	0.8386	0.7024
		TTF4t	0.5318	0.3356	-0.1021	0.3863	0.5421	0.8712	0.7808
User Expectations	0.8601	UE2s	0.5246	0.6359	-0.1794	0.4218	0.5421	0.5139	0.6901
		UE4t	0.5909	0.2840	-0.1535	0.3660	0.5140	0.7196	0.8317
		UE5t	0.5158	0.2187	-0.1841	0.3194	0.5072	0.7273	0.8860
		UE6t	0.5659	0.2535	-0.1357	0.3413	0.5519	0.7916	0.8746
		UE7t	0.3731	0.2482	-0.0159	0.1456	0.3992	0.5249	0.6925

Table 10 illustrates the results which show there are some further issues with the model when examined for tablets/mini-tablets. There are multiple items which are cross-loading at unacceptable levels with several items loading >.7. This was unexpected based on the results for smartphones. However, it is important to note that even with the cross-loading issues, items loaded highest on their intended construct. Further study of tablets and mini-tablets should be done to better understand these discrepancies as they do not occur for smartphones. The tablet/mini-tablet analysis is representative of the sample of 127 participants who either owns or regularly uses a tablet or mini-tablet. During the final review of the data analysis, item UE5 is removed from both the smartphone and tablet/mini-tablet sets

Using established guidelines, the outer loadings are examined to check for indicator reliability, also known as indicator communality (Hair et al, 2014). Examining the items, there were four which needed to be removed to meet established guidelines. However, one additional item is below .7 and at .685. Guidelines would suggest removing this item as well however, removal would leave a two item construct and that would not be desired. Likewise, this model is being tested against tablets/mini-tablets and since the goal was to create an aggregated model that supports multiple types of mobile devices, it has been left in for examination within the second set of devices but these initial four items are removed across both sets. These are the items TR9, TR10, TTF2, and UE3. For tablets/mini-tablets, the results have been analyzed two ways. First, all participants have been considered and then only those who self-identified as owners and active users of tablets/mini-tablets. This was done as there may be some accuracy issues when a user is basing their thoughts on future scenarios versus actual experience.

So, these alternatives have been captured. With all participants on tablets/mini-tablets, there were multiple cross loadings which prompted the idea to further breakdown the sample and analyze the owners and users of tablets/mini-tablets. For smartphones, 227 of the 228 sampled identified as owning or using a smartphone on a regular basis. For tablets/mini-tablets, 127 self-identified as owning or regularly using a tablet or mini-tablet. These differences were unanticipated and it leads to more questions and opportunities for further study which will be detailed later. For the present study, the analysis for tablets/mini-tablets will focus solely on this subgroup of owners and/or active users. Examining tablets/mini-tablets, there are still some issues with the structural model. For owners only, there are two items with outer loadings below .7. One is the same one which was at issue for smartphones and is at .483 and the second was not an issue for smartphones and is at .658. Further reduction of items is not ideal as it would leave a two item construct for task characteristics and then removing the additional item would create a different model for tablets than for smartphones. Prior to removing more for one type of device, future research might be best to examine all items again further with a different sample as well.

Validity. The items are next examined for convergent validity and discriminant validity. For convergent validity, each construct should account for at least 50% of the indicator's variance (Hair et al, 2010) and will also follow the guidelines of the Fornell-Larcker analysis (Fornell & Larcker, 1981). When outer loadings are greater than .40 but less than .70, it is recommended that the impact on average variance extracted (AVE) be examined and if the deletion does not increase the measure above the threshold, that the indicator still be retained (Hair et al, 2014). To check for convergent validity, the

AVE is evaluated to be greater than .5. For smartphones, all constructs have an AVE greater than .5. The Fornell-Larcker criteria is used as an assessment of discriminant validity and it compares the square root of the AVE values with the latent variable correlations with a desired result where the square root of the AVE being higher than associated correlations (Fornell & Larcker, 1981). Table 11 shows the Fornell-Larcker analysis and average variance extracted and the results show that convergent validity and discriminant validity are present for smartphones.

Table 11: Fornell-Larcker Analysis for Smartphones

Smartphones N=228	AVE	1	2	3	4	5	6	7
1 - BI/Use	.6791	.8241						
2 - Enjoyment	.7128	.7090	.8443					
3 – Task Characteristics	.8613	.0695	.0862	.9281				
4 – Tech Characteristics	.7389	.6860	.5144	-.0074	.8596			
5 – Tech Trust	.7319	.6622	.6097	.0536	.6891	.8555		
6 – Task-Technology Fit	.6965	.7166	.5747	.1555	.6641	.7053	.8346	
7 – User Expectations	.6576	.5373	.4935	-.0064	.5151	.5952	.6551	.8109
Within this table, the square root of the AVEs are reported on the diagonal and the latent variable correlations are under the diagonal.								

Table 12 shows the results for tablets/mini-tablets. For tablets/mini-tablets, convergent validity is present. For discriminant validity, one construct has issues, and this is between Task-Technology Fit and User Expectations. Although this issue is present, discriminant validity can still be present if the items load on the intended construct higher than on the other constructs.

Table 12: Fornell-Larcker Analysis for Tablets/Mini-Tablets

Tablets/Mini-Tablets N=127	AVE	1	2	3	4	5	6	7
1 - BI/Use	.6841	.8271						
2 - Enjoyment	.7502	.6904	.8661					
3 – Task Characteristics	.8334	-.0910	-.1004	.9129				
4 – Tech Characteristics	.6572	.6296	.6771	-.0558	.8144			
5 – Tech Trust	.6650	.7292	.5925	-.1257	.6742	.8107		
6 – Task-Technology Fit	.6903	.7478	.5140	-.1105	.5302	.7435	.8155	
7 – User Expectations	.6395	.6650	.4419	-.1872	.4316	.6459	.8618	.8308
Within this table, the square root of the AVEs are reported on the diagonal and the latent variable correlations are under the diagonal.								

Table 13 illustrates how Task-Technology fit loads on the appropriate construct permitting discriminant validity for tablets/mini-tablets. The model demonstrates convergent validity and discriminant validity for both smartphones and for tablets/mini-tablets.

Table 13: Assessment of Discriminant Validity for selected items

	TTF	USER EXPECTATIONS
TTF1t	0.7802	0.6677
TTF3t	0.8386	0.7024
TTF4t	0.8712	0.7808

Sample Requirements. Evaluating the data from the final survey requires separate examination of smartphones and tablets/mini-tablets. Again, the final sample size for smartphones is 228 students and active users of mobile device technologies. There were two additional participants who were eliminated from the sample results as their survey submissions were incomplete. Best practices indicate that an appropriate sample size can be derived from the number of arrows that point into a latent variable within the PLS path model (Hair et al, 2014). Within the model, the highest number of arrowheads is now 7 for the final data collection set, making a minimum sample size of 70. Following Cohen (1992), with 228 observations, it would be possible to achieve 80% statistical power for detecting R^2 values of at least .10, with a 1% probability of errors (Hair et al, 2014). With 5% probability of errors, the sample needs only to have 166 observations to achieve the same 80% statistical power for R^2 values of at least .10. However, the final model includes actually includes more than 4 arrows into any construct. Following Cohen (1992), with 228 observations, it would be absolutely possible to achieve 80% statistical power for detecting R^2 values of at least .10, with a 1% probability of errors as the minimum for 4 arrows is 191 (Hair et al, 2014). With 5% probability of errors, for 4 arrows, the sample needs only to have 137 observations to achieve the same 80% statistical power for R^2 values of at least .10. For tablet/mini-tablets, it will be possible to achieve a 10% probability of errors, for 4 arrows with a sample of only 111. The sample of 127 is within range to still achieve some statistical power. This indicates that the smartphone sample has the potential to have high levels of statistical power. The data collected and being analyzed also does not have any missing values making it more complete and ideal for analysis (Hair et al, 2010). For tablets/mini-tablets, the data has been examined against the full 228 participants and also however there were numerous cross-loadings where it appeared that the items were not loading on the proper constructs. When examining only the participants who are experienced tablet/mini-tablet users or owners, it improved the results and minimized cross-loading issues. This is possibly due to a non-tablet user's perceptions of tablet use being different than the actual experience. Therefore, for tablets/mini-tablets the reduced sample of 127 is used.

Variance Inflation Factor. To examine collinearity, SPSS 22 is used to compute the variance inflation factor (VIF) values. A maximum acceptable VIF will be 5.0, anything higher suggests an issue with multicollinearity (Hair et al, 2010). Additionally, tolerance is the amount of variance in an independent variable that is not explained by the other independent variables and tolerance values below .20 indicates a problem with multicollinearity (Hair et al, 2010). Table 14 includes the tolerance and VIF values by item for Smartphones and Tablets/Mini-Tablets. There was an issue with one item across both samples – UE5. This is removed from the final models as the levels of VIF and tolerance indicate issues with multicollinearity. However, there are additional issues with the tablet model. As previously expressed, these results will require a further analysis as the original intent was to develop a generalizable model across mobile device types. Additional perspective will be gained by further analysis of the results however, it is understood that there are some limitations with the structural model for Tablets/Mini-Tablets.

Table 14: Collinearity Assessment for Smartphones and Tablets

Smartphones

	Collinearity Statistics	
Indicator	Tolerance	VIF
EN1s	.753	1.328
EN2s	.399	2.505
EN3s	.400	2.497

Tablets/Mini-Tablets

	Collinearity Statistics	
Indicator	Tolerance	VIF
EN1t	.567	1.764
EN2t	.338	2.960
EN3t	.386	2.594

Indicator	Collinearity Statistics	
	Tolerance	VIF
TR2s	.370	2.702
TR3s	.376	2.656
TR4s	.225	4.454
TR5s	.235	4.247

Indicator	Collinearity Statistics	
	Tolerance	VIF
TR2t	.573	1.746
TR3t	.490	2.039
TR4t	.281	3.558
TR5t	.328	3.050

Indicator	Collinearity Statistics	
	Tolerance	VIF
UE2s	.708	1.413
UE4s	.647	1.546
UE5s	.184	5.450
UE6s	.293	3.412
UE7s	.282	3.544

Indicator	Collinearity Statistics	
	Tolerance	VIF
UE2t	.627	1.595
UE4t	.422	2.370
UE5t	.162	6.164
UE6t	.171	5.851
UE7t	.525	1.906

Indicator	Collinearity Statistics	
	Tolerance	VIF
SM_TAC1s	.289	3.456
SM_TAC2s	.220	4.536
SM_TAC3s	.274	3.654

Indicator	Collinearity Statistics	
	Tolerance	VIF
TAB_TAC1t	.227	4.413
TAB_TAC2t	.172	5.820
TAB_TAC3t	.222	4.496

Indicator	Collinearity Statistics	
	Tolerance	VIF
TEC1s	.486	2.057
TEC2s	.516	1.938
TEC3s	.357	2.797
TEC4s	.368	2.719

Indicator	Collinearity Statistics	
	Tolerance	VIF
TEC1t	.711	1.406
TEC2t	.631	1.584
TEC3t	.440	2.274
TEC4t	.444	2.251

Indicator	Collinearity Statistics	
	Tolerance	VIF
TTF1s	.541	1.850
TTF3s	.712	1.405
TTF4s	.496	2.017

Indicator	Collinearity Statistics	
	Tolerance	VIF
TTF1t	.576	1.736
TTF3t	.485	2.060
TTF4t	.397	2.518

Indicator	Collinearity Statistics	
	Tolerance	VIF
BI1s	.633	1.579
BI2s	.692	1.445
BI3s	.539	1.857

Indicator	Collinearity Statistics	
	Tolerance	VIF
BI1t	.537	1.862
BI2t	.519	1.927
BI3t	.399	2.507

Common Methods Bias Analysis. Often, testing shows no common methods bias as there are few alternatives for testing. Within IS, one of the most common ways to avoid common methods bias is via randomizing the variables within the survey (MacKenzie, Podsakoff & Podsakoff, 2011). This survey included randomized questions and also they were further randomized a second time between classes during data collection. Additionally, the Harman factor test was examined for both smartphones and for tablets/mini-tablets. In both instances, the model passes as the items are not all loading on one factor.

Structural Model Analysis

Hypothesized Linkages

Within the PLS structural model, the process of bootstrapping is performed to examine the level of significance of individual path coefficients (Hair et al, 2014). During this process, a number of samples are pulled from the original sample. This means that more a sample may be taken at random more than once. It is recommended to use 5,000 samples in a bootstrap procedure and as many cases as there are within the data set. For this application, bootstrapping was performed with 228 cases and 5000 samples (Hair et al, 2014). This procedure has been performed for Smartphones and also for

Tablets/Mini-Tablets. Since P-Values are not included in SmartPLS output, P-Values are calculated using the T-Dist function within Microsoft Excel. Completing this requires the T-Value, degrees of freedom and selection of a one or two tailed test. For this analysis, a two tailed test is selected. Degrees of freedom is one fewer than the number of cases or 227 in this analysis. Table 15 shows the results for Smartphones.

Table 15 - Hypotheses Testing Results - Smartphones

Hypothesis	Path Coefficient	T-Value	P-Value	Result
H1 - High enjoyment of using Smartphones positively influences technological characteristics of Smartphones.	0.068	0.973	0.332	Not Supported
H2 - Technology trust in the Smartphones to perform as intended positively influences technology characteristics of Smartphones.	0.390	6.947 ***	0.000***	Supported
H3 - Perceived user expectations of a Smartphone's capabilities to perform specific activities may positively influence technology characteristics for those activities and Smartphones.	0.077	1.712 *	0.088 *	Partially Supported
H4 - The task characteristics for a particular task may positively influence the fit achieved (task-technology fit) with a Smartphone.	0.341	2.583 ***	0.011 ***	Supported
H5 - The technology characteristics used on a Smartphone has a moderating effect on the relationship between the requirements (task characteristics) of a specific task and the fit achieved (task-technology fit) where positive system quality has a positive effect and negative system quality has a negative effect on the relationship.	1.588	10.239 ***	0.000***	Supported
H6 - Positive or negative task-technology fit has an impact on individual’s decision to use a Smartphone for specific activities.	0.541	20.337 ***	0.000***	Supported
Significance: T-Values for a two tailed test are 1.65 (.10*), 1.96 (.05**) and 2.57 (.01***); p<.10 *, p<.05 ** and p<.01 ***				

Hypothesis 1 posits a positive relationship between the enjoyment of using smartphones and the technological characteristics of those devices, however, this was not held. The path coefficient (.068) and associated p-value (.332) was not significant and this hypothesis is therefore rejected. This result is somewhat surprising in that enjoyment has been studied within the literature has been found often lead to use of a system. Understanding this further in the context of smartphones provides an opportunity for future research endeavors.

Hypothesis 2 asserts that trust in the technology positively influences the technological characteristics of smartphones and this was found to be supported and highly significant with a path coefficient of 0.390, and p-value less than .01. This hypothesized result was anticipated to be positive however, the strength of the result is more than anticipated. Hypothesis 2 is supported.

Hypothesis 3 addresses perceived user expectations, an area which is often difficult to measure. It contends that a user expectations of a Smartphone's capabilities to perform specific activities may positively influence technology characteristics for those activities on that type of device. The path coefficient (.077) and p-value of .088 is significant at the 10% level and is therefore held as somewhat significant supporting Hypothesis 3.

In Hypothesis 4, the task characteristics for a particular task may positively or negatively influence the fit achieved and this relationship is moderated by the characteristics of the technology used which in this case focuses on smartphones. This was found to positively influence fit. For this relationship, a path coefficient of 0.341

yielded an associated p-value of 0.011 which is highly significant. Therefore, Hypothesis 4 is supported.

Hypothesis 5 explores technology characteristics. In this instance, the quality of the system used on a Smartphone has a moderating effect on the relationship between the task characteristics of a specific task and the fit achieved where positive system quality has a positive effect and negative system quality has a negative effect on the relationship. This was tested twice in SmartPLS first with the direct relationship between technology characteristics and task-technology fit yielding a path coefficient of 1.588 and p-value <.01 which is highly significant. Next, the moderating relationship is tested where a new item technology characteristics * task characteristics is created. Further, the moderating relationship was found to have a path coefficient of -1.408 and a p-value of 0.018 and is significant. Therefore, the relationship between task characteristics and task-technology fit is positive, significant as a direct relationship and is also moderated by technology characteristics. What is important is that the direct relationship was also tested within the model and was not originally included. Hypothesis 5 is supported.

Hypothesis 6 advances the idea that positive or negative task-technology fit has an impact on individual's decision to use a Smartphone for specific activities. This hypothesis is supported with highly significant results. In this case, the path coefficient is .541 and the associated p-value is less than .01.

Figure 9 includes the results summary for the model from SmartPLS as tested for smartphones running the PLS logarithm. The numbers on the path lines between constructs a pointing to indicators represent the outer loadings.

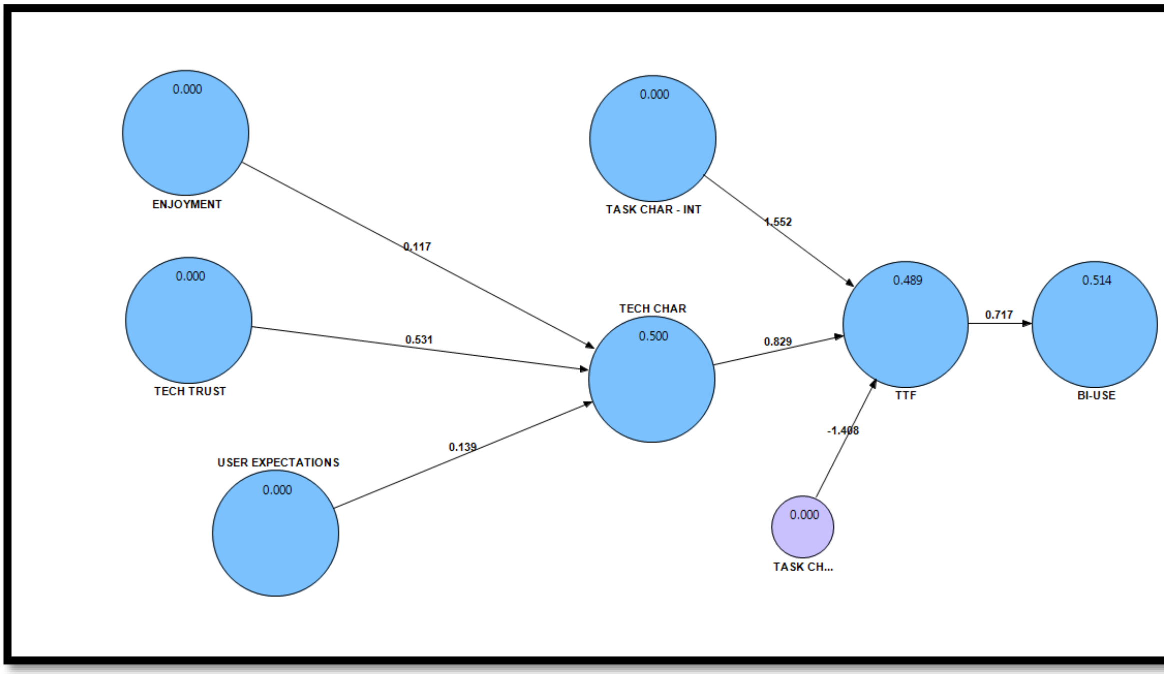


Figure 9 - Results Summary - PLS Algorithm Smartphones

Figure 10 shows the results summary for the model following the Bootstrapping procedure as tested for smartphones. The numbers on the path lines and pointing to indicators represent the t-values for the measurement and structural model estimated derived in the bootstrapping procedure (Hair et al, 2014).

Next, the analysis is completed for Tablets/Mini-Tablets. As previously discussed, the goal was to develop a model which would support multiple types of mobile devices. The findings would therefore be expected to be similar between the two tests. However, as was discovered with preliminary analyses of reliability and validity, there are some differences between them. Following in Table 16 are the results for Tablets/Mini-Tablets.

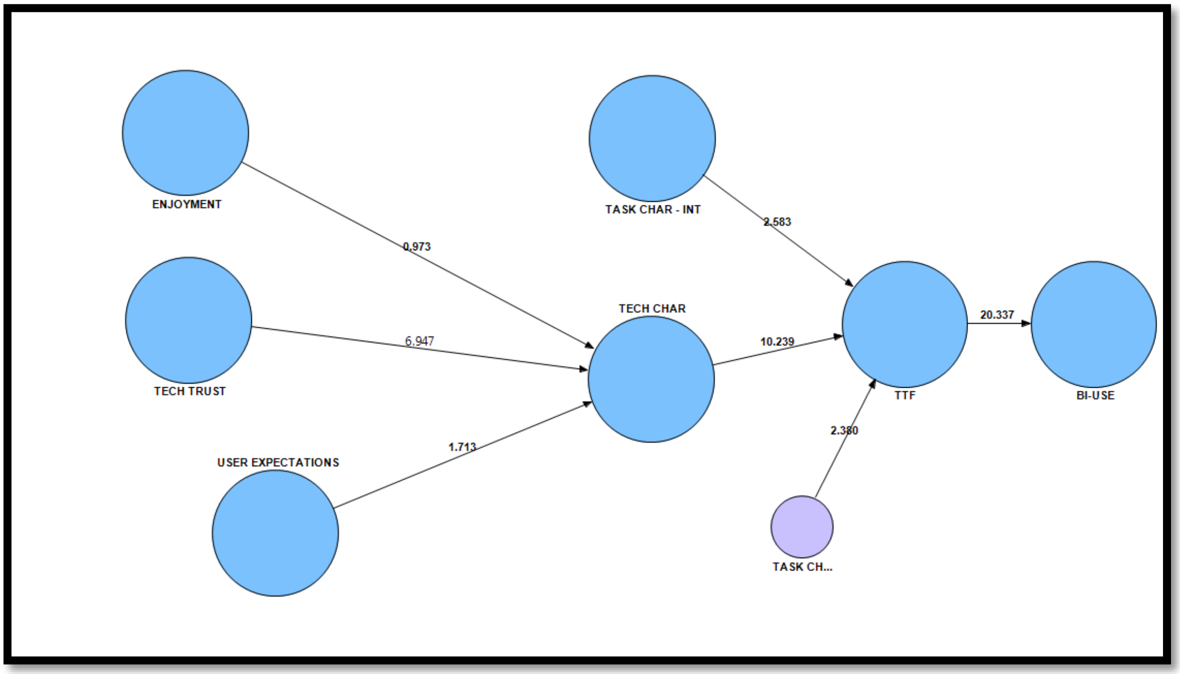


Figure 10 - Results Summary - Bootstrapping Procedure - Smartphones

Table 16 - Hypotheses Testing Results - Tablets/Mini-Tablets

Hypothesis	Path Coefficient	T-Value	P-Value	Result
H1 - High enjoyment of using Tablets/Mini-Tablets positively influences technological characteristics of Tablets/Mini-Tablets.	0.309	3.517 ***	0.001***	Supported
H2 - Technology trust in the Tablets/Mini-Tablets to perform as intended positively influences technology characteristics of Tablets/Mini-Tablets.	0.448	4.890 ***	0.000***	Supported
H3 - Perceived user expectations of a Tablet's/Mini-Tablet's capabilities to perform specific activities may positively influence technology characteristics for those activities and Tablets/Mini-Tablets.	-0.057	0.863	0.389	Not Supported
H4 - The task characteristics for a particular task may positively influence the fit achieved (task-technology fit) with Tablets/Mini-Tablets.	-0.057	0.863	0.253	Not Supported

Hypothesis	Path Coefficient	T-Value	P-Value	Result
H5 - The technology characteristics used on a Smartphone has a moderating effect on the relationship between the requirements (task characteristics) of a specific task and the fit achieved (task-technology fit) where positive system quality has a positive effect and negative system quality has a negative effect on the relationship.	0.806	6.087 ***	0.000***	Supported
H6 - Positive or negative task-technology fit has an impact on individual's decision to use a Tablet/Mini-Tablet for specific activities.	0.958	18.176 ***	0.000***	Supported
Significance: T-Values for a two tailed test are 1.65 (.10*), 1.96 (.05**) and 2.57 (.01***); p<.10 *, p<.05 ** and p<.01 ***				

First, when Hypothesis 1 is tested for tablets/mini-tablets, the positive relationship between the enjoyment of using smartphones and the technological characteristics of those devices is found to be supported and highly significant. The path coefficient (.309) and associated p-value is less than .01. This result is not surprising in that enjoyment has been studied within the literature has been found often lead to use of a system. Two possible suggestions why this may be the case could be there are more hedonic activities that are being pursued on tablets/mini-tablets and are therefore more enjoyable for the users or that users perceive their smartphones are devices they have to use whether enjoyable or not. Either way, gaining an understanding of this further in the context of tablets/mini-tablets and the difference between smartphones provides an opportunity for future research endeavors.

Hypothesis 2 asserts that trust in the technology positively influences the technological characteristics of tablets/mini-tablets and this was found to be highly significant with a path coefficient of 0.448, and p-value less than .01. This hypothesized result is supported and was anticipated to be positive. This corresponds with the results from testing smartphones where Hypothesis 2 is also supported.

Hypothesis 3 suggests that a user expectations of a tablet's/mini-tablet's capabilities to perform specific activities may positively influence technology characteristics for those activities on that type of device. The path coefficient (-.057) and p-value of .389 is not significant and is therefore rejects Hypothesis 3. This differs from the results for smartphones where a small significance was found.

In Hypothesis 4, task characteristics for a particular task may positively or negatively influence the fit achieved and this relationship is moderated by the characteristics of the technology used which in this case focuses on tablets/mini-tablets. For this relationship, a path coefficient of 0.146 yielded an associated p-value of 0.253 which is not significant. Therefore, Hypothesis 4 is not supported. This differs from the highly significant results found for smartphones and offers an additional area which could benefit from further study. Here, task characteristics did not influence fit.

Hypothesis 5 examines technology characteristics. For this instance, the quality of the system used on a tablet/mini-tablet has a moderating effect on the relationship between the task characteristics of a specific task and the fit achieved where positive system quality has a positive effect and negative system quality has a negative effect on the relationship. Again, this was tested twice in SmartPLS first with the direct relationship between technology characteristics and task-technology fit with a path coefficient of .806 and p-value <.01 which is highly significant. Then the moderating relationship where a new item technology characteristics * task characteristics is created and tested. This moderating relationship was found to have a path coefficient of -0.094 and a p-value of 0.220 and is not significant. As with smartphones the direct relationship between technology characteristics and between task-technology fit is tested. Here there is a difference in results the direct path is significant while the moderating relationship is not significant. Therefore, Hypothesis 5 is not supported. This result differs from the outcome for smartphones

Hypothesis 6 advances the idea that positive or negative task-technology fit has an impact on individual's decision to use a tablet/mini-tablet for specific activities. This hypothesis is supported with highly significant results. In this case, the path coefficient is .958 and the associated p-value is less than .01. This is consistent with the results for smartphones.

Figure 11 includes the results summary for the model from SmartPLS as tested for tablets/mini-tablets running the PLS logarithm. The numbers on the path lines between constructs a pointing to indicators represent the outer loadings.

Following in Figure 12 shows the results summary for the model following the Bootstrapping procedure as tested for tablets/mini-tablets. The numbers on the path lines and pointing to indicators represent the t-values for the measurement and structural model estimated derived in the bootstrapping procedure (Hair et al, 2014).

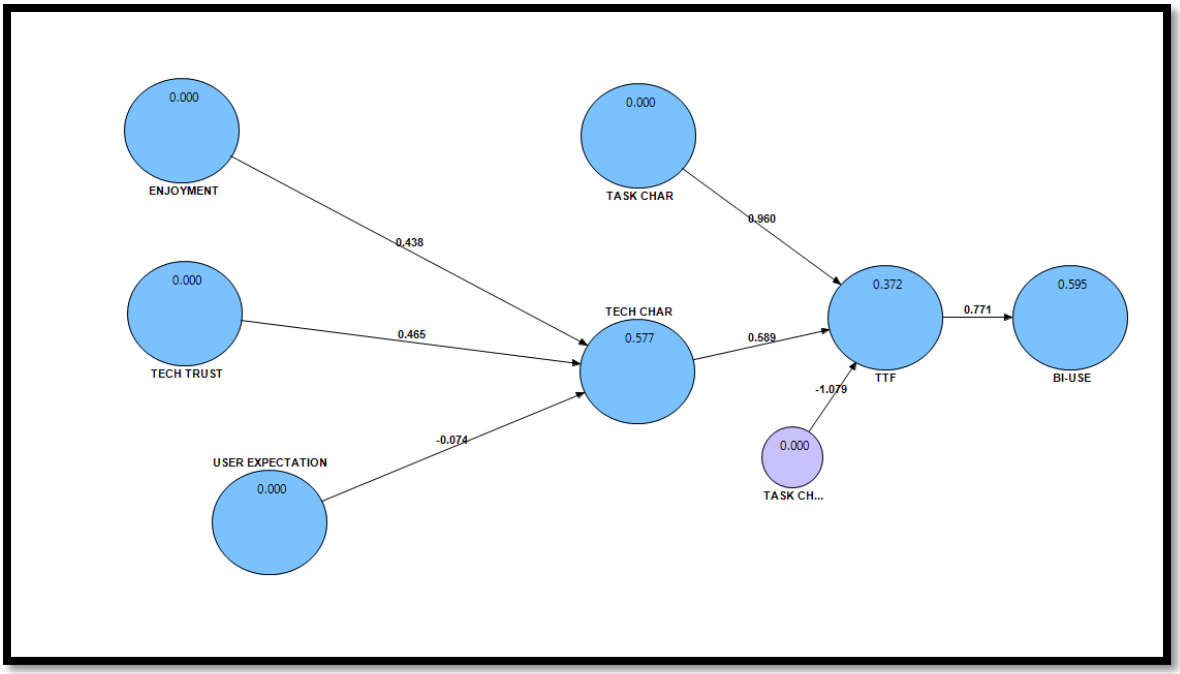


Figure 11 - Results Summary - PLS Algorithm Tablets/Mini-Tablets

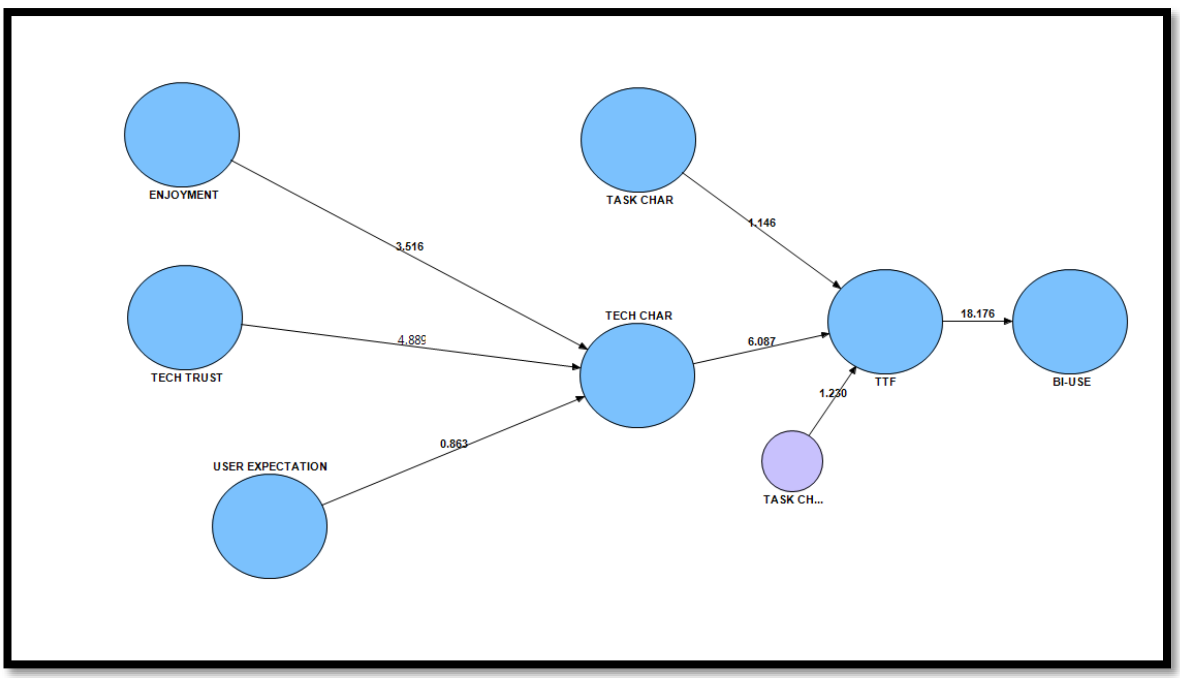


Figure 12 - Results Summary - Bootstrapping Procedure – Tablets/Mini-Tablets

Goodness of Fit and PLS

There is debate within the field as to the need for Goodness of Fit (GoF) analysis when using the partial least squares method. Much of this comes from the use of GoF with covariance based-structural equations modeling (CB-SEM). The two types of SEM measure differently and therefore, using a universal measure or index of fit may not be appropriate for PLS. This was designed to be an attempt to measure the results in the same manner between both methods. CB-SEM and PLS path modeling both use the term 'fit' but have different meanings. "Fit statistics for CB-SEM are derived from the discrepancy between the empirical and the model-implied (theoretical) covariance matrix. (Bollen, 1989, Henseler & Sarstedt, pg. 571). Contrastingly for PLS, "GoF focuses on the discrepancy between the observed (manifest variables) or approximated (latent variables) values of the dependent variables and values predicted by the model in question." (Henseler & Sarstedt, 2013, pg. 571). Further, this Henseler & Sarstedt (2013), demonstrated that "GoF does not represent a goodness of fit criterion for PLS-SEM." (Hair et al, 2014, pg. 185). Specifically, "unlike fit measures in CB-SEM, GoF is not able to separate valid models from invalid ones" (Hair et al, 2014). It is therefore possible to have a model with perfect fit within CB-SEM to end up with a GoF value of zero in PLS path modeling. As a result, it is suggested that CB-SEM is most appropriate to test theory and PLS path modeling is focused instead on prediction (Fornell & Bookstein, 1982, Henseler & Sarstedt, 2013)

"GoF indices and Chi Squares are not prominent in PLS reports" and further, "the lack of use or reporting of GoF is not necessarily a deficit." (Chin, 2010, pg. 656).

Tenenhaus, Exposito Vinzi, Chatelin & Lauro offered an index of GoF for use with PLS to address the issue that was being raised within the field (2005). However, this index has also been empirically and conceptually examined and found to be inaccurate as a fit measure and recommended not to be used as one with PLS models (Henseler & Sarstedt, 2013). Further, following best practices for reporting structural model results, a word of caution is added, "do not use the GoF" (Hair et al, 2014, pg. 186).

For these reasons, a measure of GoF is not offered within this work yet it is important to note that this subject continues to stimulate discussion among scholars within the field. Therefore it is important to at least acknowledge this discussion and offer the position taken here in this dissertation to not include GoF measures for PLS.

Model Explanatory Power – Smartphones and Tablets/Mini-Tablets

The amount of explained variance of endogenous latent variables in the structural model is called R^2 (Hair et al, 2010). To that end, the higher an R^2 value is, the better the better a construct is explained by the latent variables and the better the prediction, the primary goal of the PLS-SEM method, by the PLS path model (Hair et al, 2014). R^2 is also referred to as the coefficient of determination and is calculated as the squared correlation between a specific endogenous construct's actual and predicted values (Hair et al, 2010). Citing Chin (1998), within IS, R^2 values equal to .670 or more are considered substantial, values around .333 are considered average and values of .190 are considered low (Urbach & Ahlemann, 2010). Also, R^2 values of .75, .50 and .25 can be referred to as substantial, moderate and weak as a rough rule of thumb (Hair et al, 2014;

Hair, Ringle & Sarstedt, 2011). Table 17 shows the R^2 results for smartphones and tablets/mini-tablets.

Table 17 - Coefficient of Determination Values

Endogenous Constructs	R^2 - Smartphones	R^2 - Tablet/Mini-Tablets
Technology Characteristics	0.50	0.58
Task-Technology Fit	0.49	0.37
BI/Use	0.51	0.60

For smartphones, technology characteristics and use exhibit moderate power of predictive accuracy at R^2=.50 and R^2=.51 respectively. Task-technology fit at R^2=.49 is just under the moderate threshold rule of thumb or exceeds depending on the benchmark followed. Contrastingly, for tablets/mini-tablets, task-technology fit exhibits lower power at R^2=.37. Technology characteristics (R^2=.58) and Use (R^2=.60) demonstrates greater than moderate power of predictive accuracy.

Effect size for the smartphone model is next measured as the relative impact of a predictor construct on an endogenous construct and is represented as f^2 (Hair et al, 2014). This is calculated by the following equation (Hair et al, 2014):

$$f^2 = \frac{R^2\ included - R^2\ excluded}{1 - R^2\ included}$$

Following Cohen (1988), small, medium and large effects of the exogenous variable is represented by values of .02, .15 and .35. Effect size for smartphones is run to examine the relationship between task characteristics and use. Examining the effect size of task characteristics on task-technology fit, the result is .093 resulting in a moderately small effect size. Effect size for tablets/mini-tablets is run to examine the relationship between task characteristics and use. Examining the effect size of task characteristics on task-technology fit, the result is .126 resulting in a moderately small effect size as well.

Determining predictive relevance for smartphones in SmartPLS is accomplished using the blindfolding procedure. This is referred to as Stone-Geisser's Q^2 value (Geisser, 1974; Stone, 1974). SmartPLS calculates Q^2 using an omission distance (*D*), sum of squares total (SSO) and sum of square errors (SSE). An established number (*D*) is defined and the system will skip every so many data points by omitting them and calculating an estimate based on the remaining data points (Hair et al, 2014). For example, if *D*=4, every 4th data point would be omitted. The sample size divided by *D* should not result in an integer. If the Q^2 value is greater than zero, then there is predictive relevance (Hair et al, 2011). The following formula is computed as follows: Q^2: $1\text{-}(\sum_D SSE_D/\sum_D SSO_D)$. For this model, *D* was selected to be 7 and the procedure is run for each endogenous construct separately. The predictive relevance benchmarks of .02, .15 and .35 indicate small, medium or large predictive relevance (Hair et al, 2014). Results for technology characteristics is .361 which indicates high predictive relevance. For Task-Technology fit and for BI/Use, Q^2 is .334 and .302, respectively yielding medium predictive relevance values. Evaluating predictive relevance for tablets/mini-tablets, Results for technology characteristics is .365 which indicates high predictive relevance. For Task-Technology fit and for BI/Use, Q^2 is .309 and .221, respectively yielding medium predictive relevance values. Examining the control items yielded interesting results. Table 18 recaps the results below.

Table 18 - Predictive Relevance of Control Variables for Smartphones

Control Variable	Q2	Predictive Relevance
Attitude toward Technology	0.593	High
Generalized Trust	0.582	High
Self-Efficacy	0.373	High

This implies that the individual's attitude toward technology, generalized propensity to trust and a user's self-efficacy have an impact on the model. This makes sense given the results and the nature of the study. All three of these support the results that the users demonstrated toward using their smartphones. Table 19 displays the results for tablets/mini-tablets and each of the controls also exhibited high predictive relevance toward use.

Table 19 - Predictive Relevance of Control Variables for Tablets/Mini-Tablets

Control Variable	Q2	Predictive Relevance
Attitude toward Technology	0.529	High
Generalized Trust	0.593	High
Self-Efficacy	0.348	Medium to High

Qualitative Results

Focused Experiment

Following the pilot tests for the survey, an exploratory experimental study was conducted in the Kennesaw State University BrainLab. The purpose of this study was to use EEG recordings from the frontal lobe of the participant while performing hedonic and utilitarian tasks on two types of mobile devices. The participant in this focused experiment is a female project manager who happens to be a doctoral candidate in information systems and is 48 years old. The participant is part of a doctoral program in business from a large university in the southeastern United States. Participation was voluntary and much of what was learned in this activity will lead to establishing a larger scale experiment in future research endeavors.

Experimental procedure. After obtaining consent and briefly describing the nature of the experiment and study, the participant was fitted with a standard electrode cap for recording EEG. Sixteen channels of EEG were recorded using the BioSemi Active Two bioamplifier system connected to a Windows based computer (Active Two). The electrode cap was fitted according to the frequently used established best practice of the 10-20 system of electrode placements (Homan, Herman & Purdy, 1987). The electrodes were placed on the cap to permit recording of brain activations over the frontal lobe and scalp and were sampled at 16384 Hz using a Common Average Reference (CAR). The sixteen channels recorded were Fp2, Fp1, F4, Fz, F3, T7, C3, Cz, C4, T8, P4, Pz, P3, O1, Oz, O2 – where electrodes starting with the letter F cover the frontal and pre-frontal (Fp) lobe.

Once fitted with the cap, the participant was asked to sit still and with eyes open while next being fitted for Tobii eye tracking glasses. These eye tracking glasses resemble traditional glasses and are designed to view and record the area where a participant is looking. The goal of using these glasses was to better understand where the participant was looking when interacting with different mobile devices. There are some limitations with the capabilities of this system. Many users of mobile devices look down when holding the devices resulting in the eyes being out of range for recording or calibration. This participant wears contact lenses or glasses regularly and for this experiment, was wearing contact lenses. Several times, calibration was attempted but was not strong enough to validate use of the Tobii glasses. As a result, these were removed from the focused experiment. For future use or studies, there is a newer device which can record and track viewing of mobile devices without having to adorn the user. Future studies could employ this newer system if available or else limit to participants to those who do not wear corrective lenses. Since eye tracking was not the primary focus of the experiment but instead an augmentation, the priority measuring EEG is still intact.

In the experiment, the participant is asked to perform a specified utilitarian task using a smartphone and then a tablet. The same task is performed using each device. The devices used were an iPhone 5S and an iPad 2. The utilitarian task involved taking a short quiz using a learning management system which in this case was Desire2Learn. The mobile version of the application was not employed on either device, instead, the full desktop version was used and the participant resized the screen to appropriate sizes as needed. Next, the participant is asked to perform a specific hedonic task. Using the BrainLab's Twitter account, the user creates a posting for Twitter from the smartphone and the tablet. Brain activity is recorded for each activity within the experiment.

Results. Sadly, there were challenges which did not manifest until the analysis of the four separate recordings from the sixteen channels of scalp based electrodes. Using a previously validated technique for brain localization and associated software:

standardized low resolution brain electromagnetic tomography (sLORETA) (Pascual-Marqui, 2002), and analyzing offline, issues were discovered. The analysis and brain activations were expected to be presented here as an example case of what was discovered using neurophysiological tools. However, it became clear when using the sLORETA system that there was a previously unknown technical challenge with the electrodes and intermittently the signal did not record as intended. Active electrodes are expensive and lacking a second set of electrodes, to investigate using neurophysiological tools, required another experiment.

Secondary focused experiment. Since there is an interest in utilizing Tobii eye tracking glasses as part of NeuroIS work, and since this was a part of the initial study design, the second study was focused on learning more about what the user's attention is focused on while performing the activities. Typically, users with light colored eyes are better candidates for eye tracking. When using the system, before any data can be collected, the user has to be calibrated to the device. This involves the device's two cameras being trained on the user's gaze and the user's eye. Once the system can confirm that it can detect accuracy and tracking ability, then it can be used to record what a user sees. These are measured in 1 to 5 stars each indicating intensity. For the first participant, who has brown eyes, accuracy was never able to be calibrated despite tracking ability being present. If one fails, then it will not record. The second participant's, who has blue eyes, when tested yielded a single star for accuracy and a single star for tracking. This would have worked for recording purposes but a third participant was selected. Interestingly, the third participant, also with brown eyes, was able to obtain accuracy ratings of five stars in three of the four activities and tracking of one to two stars.

Table 20 - Tobii Recording - Accuracy & Tracking

Activity/Device	Accuracy	Tracking
Hedonic – Smartphone	*****	**
Hedonic – Tablet	*****	*
Utilitarian – Smartphone	*****	*
Utilitarian – Tablet	****	**

Experimental procedure. Following the same protocol for activities as intended for EEG, the participant was asked to perform specific hedonic and utilitarian tasks on two types of mobile devices, an iPhone 5S and an iPad Air. The participant in this focused experiment is a female, aged 37**,** who is an active researcher in information systems and professor in business from a large university in the southeastern United States. Activity One was the hedonic task on the smartphone. Activity Two was the hedonic task on the tablet. Next, Activity Three was the utilitarian task on the smartphone and finally, Activity Four was the utilitarian task on the tablet. Again, the utilitarian task was taking a short quiz using the Desire2Learn learning management system in the desktop version of the application. The hedonic task was creating Twitter posting for the BrainLab's Twitter account, on each device.

Results. These four separate recordings from the Tobii Glasses 1 Eye Tracker were analyzed through the Tobii Studio Eye Tracking software. In the software, the video is viewable which shows what areas a user was viewing and then overlays a dot and vector mapping over the video. The large dots are areas where the focus has been for longer than one second. The lines demonstrate the eye movement and pathway. Following in Figures 13 through 16 are images taken from the video of the participant while completing the each activity.

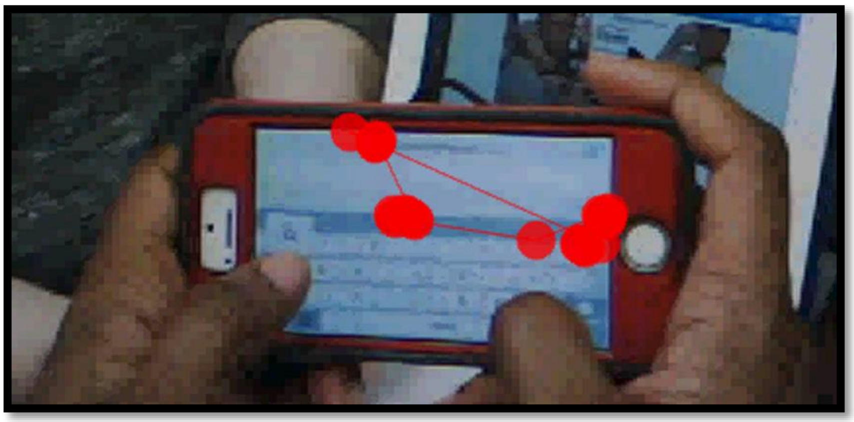


Figure 13 - Tobii Studio Software – Hedonic Smartphone

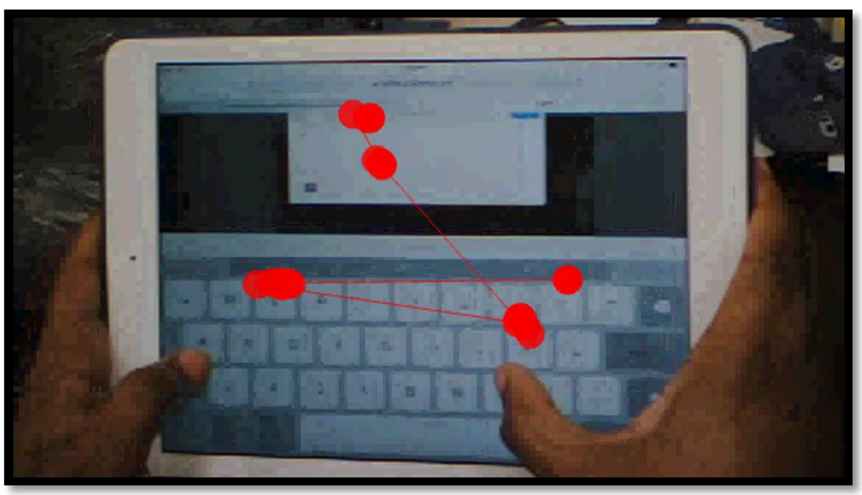


Figure 14 - Tobii Studio Software – Hedonic Tablet

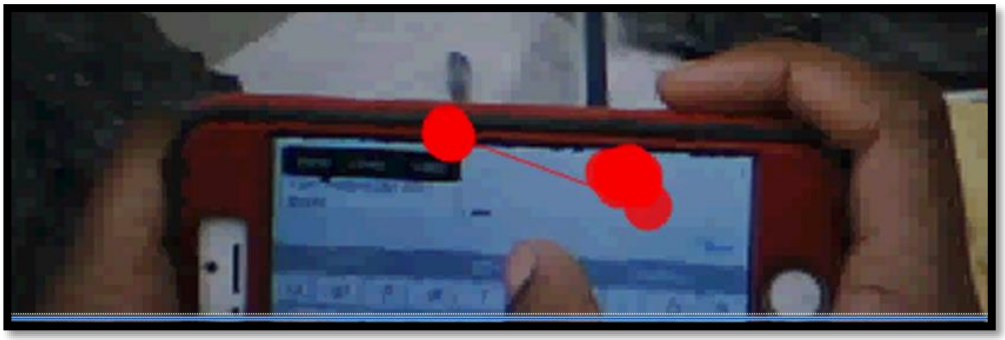


Figure 15 - Tobii Studio Software – Utilitarian Smartphone

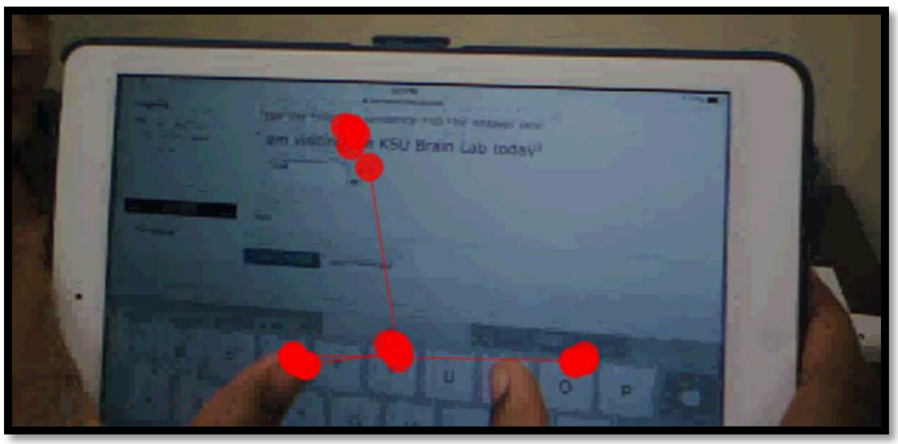


Figure 16 - Tobii Studio Software – Utilitarian Tablet

Each of the activities when examined, show a user who is proficient with the technologies. This participant owns and regularly uses an iPhone 5s which is the same type as was in this study. The participant also owns an iPad and an iPad Mini so they are familiar devices. The study was designed to correspond also with the EEG recordings so the tasks were designed to be similar in time length. In each case, the participant was asked to type in a sentence. There were no complications for the user being able to perform such tasks, and none were anticipated. Since the participant is already a user of the technology, it was anticipated that the results would demonstrate a level of comfort and proficiency. The below table summarizes the accuracy and tracking level recorded by the Tobii system.

There were some interesting findings when comparing and viewing the videos. The participant does use corrective contact lenses but is able to see the devices without any issue. In both devices, the predictive text systems which are part of Apple's iOS8 were active as is common when using either device while typing. This has to be manually turned off but was left on in all activities as many users do take advantage of the capabilities. When examining the two hedonic activities against each other and when examining the two utilitarian activities against each over the common thread was that the participant tended to use the suggested words whenever there was an option when using the smartphone but did not when using the tablet. This was interesting and when queried after the activity, the participant indicated on the tablets, it was easier view the intended text to type on a tablet than a smartphone and then she did not rely on the predictive text. Contrastingly, on the smaller keyboard of the smartphone, the predictive text system was clearly a help. Where differences also showed in this focused experiment was that it took longer to complete the hedonic activity on the smartphone than it did on the tablet. Interestingly, it took approximately a third less time on the tablet. Likewise, completing the utilitarian activity additionally took approximately one third less time on the tablet than on the smartphone. Perhaps this is due to the participant's comfort with a larger device which might offer a recommendation that they consider moving to a larger smartphone to gain more efficiency. Additionally, this opens up the opportunity to examine different age groups and populations based on their device use to learn more about how efficient and effective these devices are for completing tasks. A future investigation should return to the study’s initial purpose to complete this while wearing being measured by an EEG. It would have been interesting to examine the differences in combination and will provide for future work and research streams.

CHAPTER 5

This chapter focuses on the discussion of the results obtained from the primary study – the survey and the secondary study – the focused experiment. Next, will be a discussion of the contribution of the study results. Following that will be an evaluation of limitations and future research opportunities based on the limitations presented. Finally, concluding remarks will be offered to complete the work.

Discussion of Results

Primary Study - Survey

This study was designed to create a framework that would help better understand the types of tasks which could be performed on different types of mobile devices and users' preferences for which types of tasks they would choose to perform on which type of mobile device. Initial testing found that it was necessary to question users about specific device categories and further that their opinions could change based on the device type. So, what held true for a smartphone did not always work for a tablet or mini-tablet. This was somewhat surprising as many times the tablet is perceived to be a larger format than the smartphone and therefore easier for the user to complete tasks. Some reasons for this could include the types of tablets used not having as many features or capabilities as the user's smartphone. Participants did not always use the same products within one vendor ecosystem. For example, some participants had Android tablets and iPhones, others had Kindle Fire tablets and Android based phones or iPhones or Windows Surface tablets and a non-Windows phone. Others still had iPhones and iPads and Samsung Galaxy tablets and Galaxy or Note Phones. Perhaps those using differing operating systems perceive one as being simpler or more complete than the others. What was clear is that users in this sample are willing to use their smartphones for both hedonic and utilitarian tasks. For example, all of the survey participants reported using their smartphone to access the university's learning management system but participants then did not all indicate that they would use a tablet for the same activity. This is surprising in that the activity on a larger screen might instead offer a better user experience however, they chose to use their smartphones instead. Likewise, this population also reported actively using their smartphones for hedonic pursuits such as engaging in social media sites. This was to be expected based on the demographic mix of the participants. What was most interesting was seeing how there were differences in user perceptions between the different device types and those differences definitely warrant future investigation.

Enjoyment, a key construct which has within the literature been indicative of predicting a user's intention to use a system had interesting results in this study. So, it was expected that this would hold here however, there are differing results. For smartphones, hypothesis 1 – high enjoyment of using smartphones positively influences technological characteristics of smartphones was not supported ($p=.332$). However, for tablets/mini-tablets, the results were significant and supported the idea that high enjoyment of using tablets/mini-tablets positively influences technological characteristics of tablets/mini-tablets. This was expected as a result based on literature. Perhaps one of the reasons why there was no support for smartphones was due to the user's dependence on their smartphones and their inherent need to use them for many activities whether they enjoyed doing so or not. Additionally, it seems clear that users actively are using their smartphones for activities that are both hedonic and utilitarian and therefore enjoyment is not as important to them as instead completing their necessary tasks.

Technology Trust advances the idea that a user must trust in their technology to perform as intended and hypothesis 2 contends that technology trust in the smartphone to perform as intended positively influences technology characteristics of smartphones. This was found to be significant and did hold for smartphones. The participants exhibited trust in their technologies to do what they need them to do when performing tasks. For tablets/mini tablets, hypothesis 2 held and was significant as well. Again here, users indicated that they trusted in the technology of tablets or mini-tablets to function as needed for their tasks.

User expectations is often difficult to measure as expectations may vary by device and activity. For smartphones, hypothesis 3 stated perceived user expectations of a smartphone's capabilities to perform specific activities may positively influence technology characteristics for those activities and smartphones. In this instance this hypothesis was supported and there was some significance with $p=.088$ ($.05<p<.10$). Contrastingly, for tablets/mini-tablets the hypothesis was not supported. Here the result may be due to the limitations of the tablet hardware that the participants are using. For example, using a tablet with limited capabilities may negatively influence a user's expectations. Likewise, if they have a more capable or newer smartphone than the tablet that they are using, they may also have a negative experience. This was a little surprising because many tablets are as capable as smartphones or are even at times more capable. The issue may be this populations actual devices and in a future study, it might be interesting to revisit to see if the same result holds true.

Task characteristics proved to be an area which warrants much further study. It was not as simple as defining a task and then questioning about the characteristics of the task. Instead, this proved to be an area of much interest. As defined earlier, task characteristics represent the requirements of the specific task that needs to be completed by the information system (Goodhue & Thompson, 1995). Further broken down, representative tasks were classified as hedonic, utilitarian or mixed. A hedonic task would be one which is perceived to be fun such as interacting with social media or shopping online. A utilitarian task is one which is useful or is aided by the technology as in accessing a university's learning management software system or using an enterprise resource planning (ERP) system. A mixed task would be one which has both hedonic and utilitarian purposes and the best example of this would be an email system. When used for personal reasons, email can be quite fun and when used for work it can be functional and utilitarian for completing tasks. Hypothesis 4 stated that task characteristics for a particular task may positively or negatively influence the fit achieved (task-technology fit) and the relationship is moderated by the characteristics of the (smartphone) technology used. For smartphones, this was supported and was highly significant ($p=.011$). After assessing the different types of tasks and calculating a task score as described earlier, this outcome was not unexpected for smartphones. What was unexpected was that examining for tablets/mini-tablets resulted in the hypothesis not being supported. Yet again, this is an area where the different type of device warrants further examination. The focused experiment sought to isolate and better understand a user's preferences for performing specific tasks on different types of devices. Future research could focus on different types of devices being used for different tasks and then follow up qualitative semi-structured interviews to better understand where users' experiences differ by device types. Computing a new variable incorporating task type did not change the variable as part of the analysis. What it does show is that task characteristics is far more complicated than first thought. Likewise, task characteristics on a smartphone indeed differ when the same task is performed on a tablet/mini-tablet.

Task-technology fit is examined by hypothesis 5 which states the quality of the system used on a smartphone has a moderating effect of the relationship between the requirements (task characteristics) of a specific task and the fit achieved (task-technology fit) where positive system quality has a positive effect and negative system quality has a negative effect on the relationship. Technology characteristics where defined here as a measure of system quality. In the model, the relationship between task characteristics and task-technology fit was proposed to be moderated by technology characteristics. However, it was found that this relationship is instead a direct relationship for both smartphones and tablets/mini-tablets and is not a moderating relationship. For smartphones, hypothesis 5 was supported and was found to be highly significant ($p=.000$). For tablets/mini-tablets, hypothesis 5 was also supported and was found to be highly significant ($p=.000$). Here like in other examinations of task-technology fit, the relationships between the right task and the right technology to perform them have a positive effect while the opposite will result in a negative effect. Both smartphones and tablets/mini-tablets exhibited positive task-technology fit when performing hedonic and utilitarian tasks.

Use, or the behavioral intention to use the technology represents the penultimate measure in this model. Hypothesis 6 suggests positive or negative task-technology fit has an impact on individual's decision to use a smartphone for specific activities. For smartphones, this is supported and is highly significant (p=.000). Also, for tablets/mini-tablets this was also supported and is highly significant (p=.000). In both cases, this is would not be unexpected as the appropriate positive fit should lead to use of a system while a negative fit would likely lead to someone not using a system. In these applications, the fit is positive leading to use. Qualitative research could gain a better understanding of the user's willingness to use a particular type of mobile device for particular tasks. Also, since this holds for both smartphones and tablets/mini-tablets does not necessarily mean that it will hold for wearable technologies. Between the two types of devices tested, smartphones and tablets/mini-tablets, three hypotheses hold across both types of devices. The remaining four differ between device types and would suggest that an aggregated model that could measure across device types is not possible with these given items. It is possible that one could be created and that future one should employ analysis of more wearable devices as more have launched recently and continue to be developed. One thing that was clear was that mini-tablets could be aggregated into a category with tablets and their only difference at this time is their size. This could be revisited in the future as larger scale tablets are launched to see if this continues to hold true. Recapping hypotheses findings, following in Table 21, it illustrates the hypotheses results for both models.

Table 21 - Hypotheses Results for Both Models

Hypothesis	Smartphone Result	Tablet/Mini-Tablet Result
H1 - High enjoyment of using Smartphones or Tablets/Mini Tablets positively influences technological characteristics of Smartphones or Tablets/Mini Tablets.	Not Supported	Supported
H2 - Technology trust in the Smartphones or Tablets/Mini Tablets to perform as intended positively influences technology characteristics of Smartphones or Tablets/Mini Tablets.	Supported	Supported
H3 - Perceived user expectations of a Smartphone's or Tablet's/Mini Tablet's capabilities to perform specific activities may positively influence technology characteristics for those activities and Smartphones or Tablets/Mini Tablets.	Partially Supported	Not Supported
H4 - The task characteristics for a particular task may positively influence the fit achieved (task-technology fit) with the Smartphones or Tablets/Mini Tablets.	Supported	Not Supported
H5 - The technology characteristics used on a Smartphones or Tablets/Mini Tablets has a moderating effect on the relationship between the requirements (task characteristics) of a specific task and the fit achieved (task-technology fit) where positive system quality has a positive effect and negative system quality has a negative effect on the relationship.	Supported	Supported
H6 - Positive or negative task-technology fit has an impact on individual's decision to use a Smartphones or Tablets/Mini Tablets for specific activities.	Supported	Supported

Secondary Study – Focused Experiment

Following the several challenges that equipment issues posed, it resulted in modifications to the original plan. However, the most important thing learned while performing these separate case studies, first using EEG and second using the Tobii

Glasses 1 Eye Tracker system, was that this was a good protocol to use for a larger scale study to capture this data and so that these results can be examined together. To accomplish this, a larger population sample will need to be gathered for a future study with some small modifications. Given the limitations of not being able to calibrate for accuracy on some participants, at the prescreening stage of a larger scale study, potential participants should be fitted with the Tobii glasses and then a calibration attempt should be completed. If the potential participant cannot be calibrated to the glasses, then they should not be part of the study. The issues with the EEG electrodes will likely be remedied with the acquisition of a new set. There are newer and more improved eye tracking technologies that are available. Acquisition of newer eye tracking devices be it a wearable or not will greatly expand research opportunities especially with mobile devices. Further opportunities exist where the age and habits of individuals using the technology could be evaluated by the tasks being completed. The most interesting part of this focused experiment was the fact that the participant performed tasks quicker on a tablet than on a smartphone, saving about one-third of the time and this is something which should be examined further to see if it is an isolated experience or a phenomena that needs to be better understood. Either way, it warrants future investigation and study.

Contribution

This study represents exploratory research which combines a focus on the use of mobile devices for hedonic and utilitarian activities and then examined impact on the fit of the task with the technology. It also employed the use of a neurological tool, EEG to gain further insight into the user's participation with the devices. The goal was to gain a deeper understanding where not every device should do all things but that there are types of tasks and types of devices that are better suited for each other.

Given the learning from this study, it is clear for a population of college age targeted users, they will actively use their smartphones to engage in hedonic, utilitarian and mixed pursuits. That would suggest that application developers should keep this in mind when designing for that target audience. Likewise, some applications may not be optimized for use on a smartphone and it would be a good idea to do so to enhance the experience for this population. Mobile devices are not one size fit all users for all tasks. Instead, tasks and the devices used to perform these tasks may differ even when using devices that feature the same operating system.

Implications for Academic Researchers

The outcome yielded some results and opened up even more questions. For the population sampled, these participants were quite willing to perform a hedonic or utilitarian task on their smartphones. When faced with the same tasks on a tablet, fewer chose the tablet and still preferred their smartphones. Possibly this is due to their comfort with their smartphone's features and capabilities. It may also be due to limited capabilities on their tablet, perhaps or due to it being an older, slower model. Clearly, this group of users is focused less on the task that is to be accomplished and instead focuses on trusting that their smartphone will complete the tasks for them. This is a bit different than the traditional task-technology fit model which would match the tasks to be performed with an appropriate technology. Here, the smartphone is the technology of choice without regard to the task. From a research perspective, it opens numerous questions as to where additional examination can be made. It would be interesting to see the results from a younger student population, such as high school students and also from an older student population such as graduate students to see if these results remain the same. Likewise, it would be interesting to do a study focusing solely on users of different types of tablets and then a separate examination of wearables. This could possibly yield a better understanding of task categories for mobile device use (hedonic and utilitarian), categories of technologies (smartphone, tablet, mini-tablet and wearable) and appropriateness of fit. It was expected that hedonic tasks will perform well on mobile devices and perhaps utilitarian tasks will be more fun simply by completing them on a mobile device. With this group of participants, they willingly performed their tasks without regard to type on smartphones and some were willing to also perform them on tablets.

Comparison of hypothesis results. Specific to smartphones, enjoyment did not positively influence technological characteristics yet, for tablets, it did. The findings for smartphones are particularly interesting in that the result seems to be contrary to the literature in that enjoyment typically has a positive influence. As a result, this is an interesting finding and potential area to follow up on with future research.

It is not surprising that technology trust positively influenced technology characteristics in both smartphones and tablets. Users are depending on their devices more and more and whether it is their primary mode of communication or a tablet used for other pursuits, either way, they depend on them to work as designed. This result does support findings within the field and technology trust has been found to be also an antecedent of use. It is further anticipated that this will remain an important factor to users in future mobile device use.

User expectations offered a difference between smartphones and tablets. In this instance, smartphones were partially supported while tablets were not supported. Based on a secondary examination of the self-reported types of devices, it is possible that users were not happy with the devices they are using and that tainted the results. Some had older model equipment with limited capabilities. Then again, user expectations is a nebulous topic in and of itself in that it is often difficult to measure consistently. To understand this better, a deeper look as to what defines user expectations in terms of mobile devices could be offered in future research.

Task characteristics also offered a conundrum as it impacted task-technology fit as expected with smartphones but did not with tablets. The tablet result differs from what is expected in that the task has an impact on fit. That being said, again, there could be some limitations based on the types of technologies these users referenced. For example, if they owned the most current smartphone in a phablet size it may have more capabilities and speed than their older generation tablet. Such a scenario could account for this discrepancy and offers another area of interest for future examination. The smartphone result replicates what is expected based on the literature but the tablet result did not offering an interesting opportunity for further study.

The proposed model examined a moderating relationship between task characteristics and task-technology fit by technology characteristics, following the task-technology fit model. The smartphone and tablet/mini-tablet models demonstrated there was a direct relationship between technology characteristics and task-technology fit which was not previously included and it was significant for both types of devices. Perhaps this is due to the technology itself being an important factor in achieving fit with differing tasks. The moderating relationship did hold for the smartphones which does follow the literature. However, it did not for tablet/mini-tablets and this also offers future opportunities to explore in addition to the direct relationships found for both device types.

Finally, for both smartphones and tablets/mini-tablets, achieving appropriate fit of the task and technology used does have an impact on an individual's behavior and use of the technology. These results were definitely expected but they were also highly significant for both models. The results further supports existing research in the field where task-technology fit leads to use.

Extension to neuroIS research. This work offers a contribution to the discipline in that it is one of the first studies of its kind to incorporate the focus on mobile devices, fit and neurophysiological measures yielding an enriched understanding about a user's continued use of mobile devices. The focused experiment protocol first discussed can be treated as a pretest for a future neurophysiological examination of users and mobile devices. There are numerous future studies which can be launched from this preliminary work and is discussed later in future research opportunities.

Implications for Practitioners and Industry

This work contributes to practitioners as there is much that can be learned about users and their individual preferences for specific devices for activities. Practitioners will be able to better understand the importance of incorporating hedonic activities into utilitarian tasks and taking advantage of device capabilities hopefully leading to better design of tools and applications for future use.

The greatest opportunity for business to gain from the findings of this research is in design implications. Given the learning from this study, it is clear for a population of college age targeted users, they will actively use their smartphones to engage in hedonic, utilitarian and mixed pursuits. That would suggest that application developers should keep this in mind when designing for that target audience. Additionally, this is important as this age group is next to enter the workforce and will be prepared to use these devices from day one and may use them even if the company prefers otherwise. When managing and working with this age group, it is important to understand their preferences and the tools that they are already comfortable with as they transition from student to full time worker.

The study yielded a direct relationship between technology characteristics and task-technology fit. This is important to businesses to make sure that they are incorporating the characteristics and antecedents into design and selection of mobile devices for specific tasks. Understanding that a population of employees has an affinity for a particular type of device is valuable as efforts could be directed toward making applications compatible for the device in turn providing workers with a more positive work experience.

Leveraging the use of specific mobile devices which are perceived to be useful to this group will be instrumental in improving productivity with that group. For example, companies are beginning to transition away from traditional office related tools such as voice mail in favor of alternative such as texting or simply calling via cell phone. Knowing the habits of these workers and their predilection to use them in a ubiquitous context, it seems most prudent to design communication and activities with this in mind. This will be especially helpful with sales employees or other field-based, front line workers.

Extending further, this work examined the hardware solutions not the actual applications involved. There are opportunities for businesses to further refine and improve upon specialized applications which are used by employees by pairing the device type with the application in a more functional and fluid manner. Having an application specific for a tablet or smartphone is of little use if the targeted users prefer to use the fully developed traditional software package. Working with targeted users, the applications can then be developed to best suit their needs. Likewise, some existing applications may not yet be optimized for use on a smartphone and it would be a good idea to do so to enhance the experience for this population as the findings in this work indicate an absolute preference for smartphones over tablets in general. Mobile devices are not one size fit all users for all tasks. Instead, tasks and the devices used to perform these tasks may differ even when using devices that feature the same operating system. This will continue to evolve as the types of devices developed have further feature enhancements, different methods of interactions and improved speed and battery life capabilities. As a result, this will not be a simple one time fix but instead an evolutionary opportunity to develop tools to increase profitability, efficiency and effectiveness within an organization.

Additional information gained from further assessments with neurophysiological tools, such as using EEG or eye-tracking, while performing tasks will also have implications for businesses. These results will be able to offer a different level of understanding beyond simply the individual's self-report via a survey. Such knowledge may help further in the design and development of appropriate tasks and recommendations as to which mobile device is best suited to them.

Limitations and Future Research Opportunities

One limitation is that the study focuses solely only on mobile devices. Despite a provided explanatory definition, some participants still viewed other devices as inclusive of mobile devices such as wearable fitness trackers or even portable 2 in 1 tablet laptop computers. To address that concern, in future research, the experiment could be replicated asking users to complete hedonic and utilitarian tasks on a specific traditional desktop or laptop computer in addition to mobile devices. Another limitation is that the participants seemed to have a dominant affinity for one operating system. Additionally, in the experiment, only iOS was chosen and two Apple devices were used. This can be rectified with future research studying more than one preferably Android and Windows operating systems in addition to compare with the iOS systems. This could be done in a comparison to the original via a replicated experiment. Also, some may say that a limitation is the use of EEG to develop an experimental protocol for future experiments. Instead, it is an opportunity to leverage new technologies in the field. To address this requires more work within the discipline so that others may truly understand the value of Neuro-IS methods to the field. One way to change any negative perceptions is with more research and this study creates several new directions to pursue. This focused experiment has limitations in that it is an activity performing hedonic and utilitarian tasks on a limited group of mobile devices and there is only one participant but to develop a future protocol, this is adequate. Additionally this leads to an immediate opportunity to roll out a more formal larger scale experiment where more observations can be obtained across multiple mobile device types and using multiple operating systems (iOS and Android) instead of a single one (iOS). Some may also say there are limitations with the method used, PLS-SEM, yet for experimental research, complex models and smaller samples, it is a recommended method which is recognized by many and already accepted within the information systems field.

Another opportunity where this work can be further explored is in other cultures to see if results gleaned hold across cultures or if the difference in cultures has an impact on the role of fit that was previously not known. Much research is conducted in countries where mobile device adoption and use is even stronger than in the United States. Several Asian countries such as Japan actively use mobile devices for mobile payments already (Amoroso & Magnier-Watanabe, 2012) and what has been learned there about consumer use can be influential for the United States. Likewise, it would be interesting to see if there is a difference in fit across cultures especially in an area where the culture already is more accepting of the technology. The differing nature of how technology is developed for the Japanese market versus the American market is interesting to examine. In the United States, larger telecommunications carriers and product developers will make an investment in application development when there is consumer demand to adopt the product while in Japan, investment is made earlier between carriers and research laboratories to develop the applications (Amoroso & Ogawa, 2011). Using and developing research tools which can help to better understand fit may be able to assist in developing better technologies for mobile devices, more appropriate designs for mobile device interface and a better synthesis of the interaction of mobile devices and their optimized applications.

Presently, this study offers knowledge about one group of users of mobile technologies, that being traditional college aged students. However as heavy users of the technology and the next to enter the workforce, making them a group worth examining in this context and of interest to businesses. Further, there are additional opportunities with conducting the same type of research with different age ranges and user populations to see what preferences are learned allowing companies to address the needs of all workers within their organization. What may also be learned is that there is an additional difference beyond simply age or gender but also based on the nature of the work performed and level of the individual within the organization. Perhaps more managers prefer to use their tablets to view dashboards of key metrics instead of using a smartphone for engaging with the same information. Frequency of use can also be examined and these can help develop a better deployment and use plan within an organization rather than simply purchasing devices due to their novelty and handing them to employees.

This could also be examined further across cultures within organizations both at a company level, or within a specific discipline and additionally based on an individual's own culture. For example, might accounting employees be more likely to adopt use of tablets than sales personnel or vice versa. Perhaps international employees might have more willingness to depend on mobile devices than local employees. The opportunities are present and anticipated to continue as individuals remain users of mobile technologies

A final area of potential future extended research is examining the connections between fit, hedonic and utilitarian tasks and the concept of flow activity, or optimal experience offering another deeper understanding of user behavior and is based on the work of Csikszentmihalyi (1990). The focused experiment offers an initial exploration of user behavior and there is a natural extension to leverage this initial study and use neurophysiological tools to further explore flow activity and optimal experience behavior in a future experiment.

Concluding Remarks

In summary, this effort sought to better understand the use of mobile devices for specific tasks. Through this research, an evaluation of mobile devices as part of an aggregated model yielded the need to separate out into different categories and then study the categories separately. Future research can focus on gaining additional knowledge about individual tasks beyond simply the characteristics and then also augmenting the study with additional different devices as they are introduced. This stream may prove to be fruitful to learning more about user's habits and their devices in the coming years. Branching out from the initial targeted population, there are expected to be different learnings which will come from an older audience and possibly differences may exist in different cultures. This present study will serve as a spring board for numerous future areas of research and will continue to evolve the knowledge base for both academics and practitioners in the coming years.

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APPENDICES

APPENDIX 1 – Preliminary Study of Mobile Device Categories

A preliminary study was completed to examine the proposed definitions of the mobile device categories delineated for this research. The preliminary study consisted of a survey asking users of mobile device technology open-ended questions and confirmatory, self-assessment questions about their own mobile device use. All data collected was anonymized for privacy. Upon completion of this preliminary study, the results indicated that the participants agreed with the classification framework - smartphone, mini-tablet, tablet and wearable. Where respondents differed was with some of the examples which were provided to add clarity to the categories; some respondents indicated that the certain examples were not relevant (i.e. Blackberry should no longer be included in the smartphone category). This is due to users perceiving that the older technology is not applicable for the study. Overall, the examples of the items in each category were deemed appropriate.

The preliminary study resulted in sampling 148 users of mobile devices and was conducted at a large regional comprehensive university in the Southeast United States. The participants were predominantly students and ranged in age from 18 to 52, with an average age of 22.9 years having varying degrees of experience with mobile devices. There were 86 males and 62 females who participated in this preliminary study. Out of 148 respondents, 129 (88%) self-identified as owning at least one mobile device, 18 (12%) did not own any mobile devices and one did not respond.

Additionally, the 129 students self-reported owning and using 239 devices ranging from 1 to 4 (average of 1.9) devices per person. The 18 students who did not presently have mobile devices were asked about their interest in future ownership and 12 had an interest in owning a mobile device and 6 expressed a desire against obtaining a mobile device in the future. This group of 6 was made up of one female and 5 male students. All students were asked about which mobile device category they might want to adopt from in the future. Students expressed an interest adopting in all categories: Smartphone – 17, Mini-Tablet – 11, Tablet – 39 and Wearable – 22.

Students were encouraged to participate in this study and received one point added to their final average out of a 100 point scale. Students were an acceptable group for this preliminary study in that they were familiar with the subject of the experimental task of the use of mobile devices (Gordon, Slade & Schmitt, 1986). As of 2013, smartphone ownership remains high among younger adults with 79% of those aged 18-24 and 81% of those aged 25-34 having smartphones (Smith, 2013b). Additionally, tablet ownership among 18-29 year olds is at 37% but that number is likely to increase as 16-17 year old ownership is at 46% (Rainie & Smith, 2013). This further supports that students are ideal as current users of the technology to participate in these studies.

Survey for Mobile Device Categories Validation

Instructions to students: The following descriptions represent four types of mobile devices. I am hoping to learn more about your opinions as a user of mobile devices. Please read the category descriptions and keep them in mind while answering the questions as completely as possible.

Categories Provided

Device Category	Description	Examples of Devices in the Category
Smartphone	A mobile portable device that: • Makes telephone calls • Accesses the Internet • Uses specialized applications • Can send and receive text and electronic mail messages • Ranges in diagonal screen size of approximately 4 to less than 7 inches • Typically is used by one individual • Has an integrated keyboard and/or touch based interface	• Apple's iPhones • Samsung's Galaxy or Note • Blackberry devices • Windows Phone
Mini-Tablet	A mobile portable device that: • Accesses the Internet • Uses specialized applications • Can send and receive text and electronic mail messages • Ranges in diagonal screen size of approximately more than 7 to less than 9 1/2 inches • May be used by more than one user • Has a flat surface • Has a touch based interface	• Amazon's Kindle Fire HD • Apple's iPad Mini • Samsung's Galaxy Tab series (less than 10 inches) • Google Nexus 7
Tablet	A mobile portable device that: • Accesses the Internet • Uses specialized applications • Can send and receive text and electronic mail messages • Ranges in diagonal screen size of greater than 9 1/2 inches • May be used by more than one user • Has a flat surface • Has a touch based interface	• Amazon's Kindle Fire HD • Apple's iPad • Samsung's Galaxy Tab series (greater than 10 inches) • Sony Xperia • Windows Surface

Wearable	A mobile portable device that: • The user adorns the device (For example: wears like eyeglasses or like a watch) • May connect to other products • May connect to the Internet	• Google Glass • Samsung Gear

Questions

1	Are there any categorical descriptions with which you disagree?	Yes / No
2	If there are any categorical descriptions with which you disagree, how would you change it/them?	Short Answer
3	Are there any categorical examples with which you disagree?	Yes / No
4	If there are any categorical examples with which you disagree, how would you change it/them?	Short Answer
5	Do you have any mobile devices that are part of these categories?	Yes / No
6	How many mobile devices do you own and/or use?	Short answer (number)
7	Which mobile devices do you have, from which categories, and how frequently do you use them?	Which device: Short Answer (category – brand device name) Frequency: ranked from 1 to 10 anchored on ‘almost never’ to ‘always’
8	If you do not have any of these mobile devices, which categories of devices would you want? Why?	Short Answer
9	Do you feel limited in how you can use your current mobile device(s)?	Yes/No
10	What features/capabilities would you change in your current mobile device(s)?	Short answer
11	Do you have any other comments to offer about mobile devices?	Short answer
12	What is your experience level with mobile devices?	Rank yourself from 1 to 10 with 1 being Beginner/Novice and 10 being Expert
13	What is your experience level with computer-based technology in general?	Rank yourself from 1 to 10 with 1 being Beginner/Novice and 10 being Expert
14	For demographic purposes, what is your age?	Short answer (number)
15	Gender?	M / F
16	What is your annual household income?	Short answer (number)

APPENDIX 2 – Survey, Scales and Sources – Initial Survey Instrument

Italicized words within the Adapted Question indicates a modification in words used to reflect mobile devices as the focus and does not affect the underlying nature of the question. The phrase "retained as original" under Proposed scale indicates that the same scale is being used as in the original source indicated. It is anticipated that there will be a reduction in questions as a result of pilot testing.

Sample instructions: Think about the following categories of mobile devices and any devices from these categories that you have used: *Smartphone, Mini-Tablet, Tablet and Wearable*. Please then consider this device/these devices when answering the following questions.

Number	Adapted Question	Proposed scale	Original Article Citation
ENJOYMENT			
1	I find using *mobile devices* to be enjoyable.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
2	The actual process of using *mobile devices* is pleasant.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.

Number	Adapted Question	Proposed scale	Original Article Citation
3	I have fun using *mobile devices.*	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
4	I would have fun interacting with a *mobile device*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Wakefield, R. L., & Whitten, D. (2006). Mobile computing: a user study on hedonic/utilitarian mobile device usage. *European Journal of Information Systems*, 15(3), 292-300.
5	Using a *mobile device* would provide me with a lot of enjoyment.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Wakefield, R. L., & Whitten, D. (2006). Mobile computing: a user study on hedonic/utilitarian mobile device usage. *European Journal of Information Systems*, 15(3), 292-300.
6	I would enjoy using a *mobile device*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Wakefield, R. L., & Whitten, D. (2006). Mobile computing: a user study on hedonic/utilitarian mobile device usage. *European Journal of Information Systems*, 15(3), 292-300.
7	Using a *mobile device* would bore me.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; (reversed); retained as original	Wakefield, R. L., & Whitten, D. (2006). Mobile computing: a user study on hedonic/utilitarian mobile device usage. *European Journal of Information Systems*, 15(3), 292-300.

Number	Adapted Question	Proposed scale	Original Article Citation
TECHNOLOGY TRUST			
8	I think *mobile devices have* the functionality I need.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
9	*Mobile devices have* the ability to do what I want them to do.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
10	Overall, *mobile devices have* the capabilities I need.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
11	I think *mobile devices are* very reliable.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.

Number	Adapted Question	Proposed scale	Original Article Citation
12	To me, *mobile devices are* very dependable.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
13	*Mobile devices behave* in a predictable way.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
14	I feel like my privacy is protected by *mobile devices.*	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Ha, S., & Stoel, L. (2009). Consumer e-shopping acceptance: Antecedents in a technology acceptance model. *Journal of Business Research*, *62*(5), 565-571.
15	I feel safe in my transactions with *mobile devices*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Ha, S., & Stoel, L. (2009). Consumer e-shopping acceptance: Antecedents in a technology acceptance model. *Journal of Business Research*, *62*(5), 565-571.
16	*Mobile devices* have adequate security features.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Ha, S., & Stoel, L. (2009). Consumer e-shopping acceptance: Antecedents in a technology acceptance model. *Journal of Business Research*, *62*(5), 565-571.

Number	Adapted Question	Proposed scale	Original Article Citation
17	The company or *companies* behind the *mobile device* are reputable.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Ha, S., & Stoel, L. (2009). Consumer e-shopping acceptance: Antecedents in a technology acceptance model. *Journal of Business Research*, *62*(5), 565-571.
USER EXPECTATIONS			
18	I find mobile *devices* useful in my daily life.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
19	Using mobile *devices* increases my chances of achieving things that are important to me.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
20	Using mobile *devices* help me accomplish things more quickly.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
21	Using mobile *devices* increases my productivity.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.

Number	Adapted Question	Proposed scale	Original Article Citation
TECHNOLOGY CHARACTERISTICS			
22	Learning to operate *mobile devices* is easy for me.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
23	I find it easy to get *a mobile device* to do what I want it to do	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
24	It is easy for me to become skillful at using *mobile devices*.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
25	I find *mobile devices* easy to use.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
TASK CHARACTERISTICS			
26	Do *you* need to work on the move or in a different place regularly *on mobile devices*?	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Liang, T. P., Huang, C. W., Yeh, Y. H., & Lin, B. (2007). Adoption of mobile technology in business: a fit-viability model. *Industrial Management &*

Number	Adapted Question	Proposed scale	Original Article Citation
			Data Systems, 107(8), 1154-1169.
27	Will information delay significantly affect the performance of the task *on mobile devices*?	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Liang, T. P., Huang, C. W., Yeh, Y. H., & Lin, B. (2007). Adoption of mobile technology in business: a fit-viability model. *Industrial Management & Data Systems*, 107(8), 1154-1169.
28	Will the performance of the task be substantially poorer if it is performed in a different place or at a different time *on mobile devices*?	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Liang, T. P., Huang, C. W., Yeh, Y. H., & Lin, B. (2007). Adoption of mobile technology in business: a fit-viability model. *Industrial Management & Data Systems*, 107(8), 1154-1169.
TASK-TECHNOLOGY FIT			
29	Using *mobile devices* fits well with the way I like to work.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36
30	*Mobile devices* are compatible with all aspects of my work.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36
31	I have ready access to *mobile devices* when I need it.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36

Number	Adapted Question	Proposed scale	Original Article Citation
32	*Mobile devices* are easy to use.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36
33	*Mobile devices* are user-friendly.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36
34	It is easy to get *mobile devices* to do what I want them to do.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36
35	*Mobile devices* are easy to learn.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36
36	It is easy to become skillful at using *mobile devices.*	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36
37	New features are easy to learn.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC),* 16(4), 17-36

Number	Adapted Question	Proposed scale	Original Article Citation
38	Do you think the output (*display*) is presented in a useful format?	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC)*, 16(4), 17-36
39	Are *mobile devices* accurate?	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC)*, 16(4), 17-36
40	Do *mobile devices* provide up-to-date information?	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Staples, D. S., & Seddon, P. (2004). Testing the technology-to-performance chain model. *Journal of Organizational and End User Computing (JOEUC)*, 16(4), 17-36
CONSUMER USE OF MOBILE DEVICES			
41	Please choose your usage frequency for the following: *Smartphone*	7 point Likert Scale; 1=Never and 7=Many times per day; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
42	Please choose your usage frequency for the following: *Tablet*	7 point Likert Scale; 1=Never and 7=Many times per day; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
43	Please choose your usage frequency for the following: *Mini-Tablet*	7 point Likert Scale; 1=Never and 7=Many times per day; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of

Number	Adapted Question	Proposed scale	Original Article Citation
			technology. *MIS Quarterly*, 36 (1), 157-178.
44	Please choose your usage frequency for the following: *Wearable*	7 point Likert Scale; 1=Never and 7=Many times per day; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
44	I want to continue using my *mobile devices* rather than discontinue *their* use.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Bhattacherjee, A. (2001). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems*, 32(2), 201-214.
45	My intentions are to continue using my *mobile devices* rather than any alternative means.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Bhattacherjee, A. (2001). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems*, 32(2), 201-214.
46	If I could, I would like to discontinue use of my *mobile devices*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Bhattacherjee, A. (2001). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems*, 32(2), 201-214.
CONTROL, EXPERIENCE SPECIFIC & DEMOGRAPHIC VARIABLES			
47	Computers make work more interesting.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Jarvenpaa, S. L., Tractinsky, N., Saarinen, L. & Vitale, M. (1999). Consumer trust in an Internet store: A cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 1-35.

Number	Adapted Question	Proposed scale	Original Article Citation
48	I enjoy interacting with computers.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Jarvenpaa, S. L., Tractinsky, N., Saarinen, L. & Vitale, M. (1999). Consumer trust in an Internet store: A cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 1-35.
49	Working with computers is fun.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Jarvenpaa, S. L., Tractinsky, N., Saarinen, L. & Vitale, M. (1999). Consumer trust in an Internet store: A cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 1-35.
50	I use computers for fun.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Jarvenpaa, S. L., Tractinsky, N., Saarinen, L. & Vitale, M. (1999). Consumer trust in an Internet store: A cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 1-35.
51 a	Do you own or use any *mobile devices* (smartphone, mini-tablet, tablet or wearable)?	Yes or No	For demographic/survey purposes
51 b	Which ones and how many of each?	Select from list and enter number	For demographic/survey purposes
52	The use of *mobile devices* has become a habit for me.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.

Number	Adapted Question	Proposed scale	Original Article Citation
53	I am addicted to using *mobile devices*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
54	I must use *mobile devices.*	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
55	Using *mobile devices* has become natural to me.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
56	What is your age?	User provided number	Randolph, A. B. and M. M. Moore Jackson (2010). "Assessing Fit of Nontraditional Assistive Technologies." ACM Transactions on Accessible Computing 2(4): 1-31.
57	What is your gender?	Male, Female or Intersex	Randolph, A. B. and M. M. Moore Jackson (2010). "Assessing Fit of Nontraditional Assistive Technologies." ACM Transactions on Accessible Computing 2(4): 1-31.
58	I could complete the job using *mobile devices*…	Instructions provided with scale following	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*,19(2), 189-211.

Number	Adapted Question	Proposed scale	Original Article Citation
59 a	…if there was no one around to tell me what to do as I go	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*,19(2), 189-211.
59 b	…if I had never used *a mobile device* like it before	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*,19(2), 189-211.
59 c	…if I had only the manuals/*instructions* for reference	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*,19(2), 189-211.
59 d	…if I had seen someone else using it before trying it myself	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*,19(2), 189-211.
59 e	…if I could call someone for help if I got stuck	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.

Number	Adapted Question	Proposed scale	Original Article Citation
59 f	…if someone else had helped me get started	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
59 g	…if I had a lot of time to complete the job for which the *mobile device* was provided	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Campeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
59 h	…if I had just the built-in help *feature* for assistance	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
59 i	…if someone showed me how to do it first	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
59 j	…if I had used similar *mobile devices* before this one to do the same job	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.

Number	Adapted Question	Proposed scale	Original Article Citation
60	Do you feel limited in how you can use your current mobile device(s)?	Yes/No	For demographic/survey purposes
61	Do you have any other comments to offer about mobile devices?	User provided comments	For demographic/survey purposes
62	What is your major?	User provided response	For demographic/survey purposes
63	What is your year in school?	User selects one of the following: Freshman, Sophomore, Junior, Senior, Graduate Student, Not Applicable	For demographic/survey purposes
64	What is your annual household income? (If you live with your parents/guardians, please only include your income)	User provided entry (dollar figure)	For demographic/survey purposes

APPENDIX 3 – Survey, Scales and Sources – Final Survey Instrument

Italicized words within the Adapted Question indicates a modification in words used to reflect mobile devices as the focus and does not affect the underlying nature of the question. The phrase "retained as original" under Scale indicates that the same scale is being used as in the original source indicated. Items were asked twice based on the devices. These are indicated by 2 questions being placed within a block. Constructs are labeled by their identifier. Within the analysis and models, the addition of S would indicate the construct for smartphones and T would indicate the construct for tablets/mini-tablets.

General instructions: You will be asked a series of questions regarding your use of specific mobile devices. First you will be asked about your use of *Smartphones* and then you will be asked your opinions about using *Tablets/Mini-Tablets*. Please then consider the device/devices that you use most when answering the following questions. Additionally, specific instructions were given to focus on other mobile devices or mobile devices in general at specific points during the survey.

ID	Adapted Question	Scale	Original Article Citation
ENJOYMENT			
EN1	I have fun interacting with *smartphones*. I have fun interacting with *tablets/mini-tablets*.	7 point Likert Scale; retained as original	Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, 665-694.

ID	Adapted Question	Scale	Original Article Citation
EN2	Using *smartphones* provides me with a lot of enjoyment Using *tablets/mini-tablets* provides me with a lot of enjoyment.	7 point Likert Scale; retained as original	Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, 665-694.
EN3	I enjoy using *smartphones*. I enjoy using *tablets/mini-tablets*	7 point Likert Scale; retained as original	Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, 665-694.
TECHNOLOGY TRUST			
TR2	*Smartphones* have the ability to do what I want them to do. *Tablets/mini-tablets* have the ability to do what I want them to do	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
TR3	Overall, *smartphones* have the capabilities I need. Overall, *tablets/mini-tablets* have the capabilities I need.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
TR4	I think *smartphones* are very reliable. I think *tablets/mini-tablets* are very reliable.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.

ID	Adapted Question	Scale	Original Article Citation
TR5	To me, *smartphones* are very dependable. To me, *tablets/mini-tablets* are very dependable.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
TR9	I feel confident that encryption and other technological advances with *smartphones* make it safe for me to do business on them. I feel confident that encryption and other technological advances with *tablets/mini-tablets* make it safe for me to do business on them.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
TR10	In general, *smartphones* are a robust and safe environment in which to transact business. In general, *tablets/mini-tablets* are a robust and safe environment in which to transact business.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Thatcher, J., Carter, M., Li, X. & Rong, G. (2013). A Classification and Investigation of Trustees in B-to-C e-Commerce: General vs. Specific Trust. *Communications Of The Association For Information Systems*, 32(4), 107-134.
USER EXPECTATIONS			
UE2	Using *smartphones* increases my chances of achieving things that are important to me. Using *tablets/mini-tablets* increases my chances of achieving things that are important to me.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.

ID	Adapted Question	Scale	Original Article Citation
UE3	Using *smartphones* help me accomplish things more quickly. Using *tablets/mini-tablets* helps me accomplish things more quickly.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
UE4	Using *smartphones* increases my productivity. Using *tablets/mini-tablets* increases my productivity.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
UE5	Using *smartphones* enhances my effectiveness in college. Using *tablets/mini-tablets* enhances my effectiveness in college.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, 665-694.
UE6	I find *smartphones* useful in my college activities. I find *tablets/mini-tablets* useful in my college activities.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, 665-694.
TECHNOLOGY CHARACTERISTICS			
TEC1	Learning to operate a *smartphone* is easy for me. Learning to operate a *tablet/mini-tablet* is easy for me.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.

ID	Adapted Question	Scale	Original Article Citation
TEC2	I find it easy to get a *smartphone* to do what I want it to do. I find it easy to get a *tablet/mini-tablet* to do what I want it to do.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
TEC 3	It is easy for me to become skillful at using *smartphones*. It is easy for me to become skillful at using *tablets/mini-tablets*.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
TEC4	I find *smartphones* easy to use. I find *tablets/mini-tablets* easy to use.	7 point Likert Scale; retained as original	Sun, H., & Zhang, P. (2006). Causal Relationships between Perceived Enjoyment and Perceived Ease of Use: An Alternative Approach. *Journal of the Association for Information Systems*, 7(9), 618-644.
TASK CHARACTERISTICS			
TAC1	I need to work on the move or in different places regularly on *smartphones*. I need to work on the move or in different places regularly on *tablets/mini-tablets*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Liang, T. P., Huang, C. W., Yeh, Y. H., & Lin, B. (2007). Adoption of mobile technology in business: a fit-viability model. *Industrial Management & Data Systems*, 107(8), 1154-1169.
TAC2	Information delay significantly affects the performance of my tasks on *smartphones*. Information delay significantly affects the	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Liang, T. P., Huang, C. W., Yeh, Y. H., & Lin, B. (2007). Adoption of mobile technology in business: a fit-viability model. *Industrial Management & Data Systems*, 107(8), 1154-

ID	Adapted Question	Scale	Original Article Citation
	performance of my tasks on *tablets/mini-tablets*.		1169.
TAC3	The performance of the task will be substantially poorer if it is performed in a different place or at a different time on a *smartphone*. The performance of the task will be substantially poorer if it is performed in a different place or at a different time on a *tablet/mini-tablet*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Liang, T. P., Huang, C. W., Yeh, Y. H., & Lin, B. (2007). Adoption of mobile technology in business: a fit-viability model. *Industrial Management & Data Systems*, 107(8), 1154-1169.
TASK-TECHNOLOGY FIT			
TTF1	Using *smartphones* fits well with the way I like to work. Using *tablets/mini-tablets* fits well with the way I like to work.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, 2(3), 192-222.
TTF2	*Smartphones* are compatible with all aspects of my work. *Tablets/mini-tablets* are compatible with all aspects of my work.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, 2(3), 192-222.
TTF3	Using a *smartphone* is completely compatible with my current situation. Using a *tablet/mini-*	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information*

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	tablet is completely compatible with my current situation.		*Systems Research*, 2(3), 192-222.
TTF4	Using a *smartphone* fits into my work style. Using a *tablet/mini-tablet* fits into my work style.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Taylor, S., and Todd, P. A. (1995) Assessing IT usage: The role of prior experience. *MIS Quarterly* 19(2), 561-570.
CONSUMER USE OF MOBILE DEVICES			
BI1	I intend to continue using *smartphones* in the future. I intend to continue using *tablets/mini-tablets* in the future.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
BI2	I will always try to use a *smartphone* in my daily life. I will always try to use a *tablet/mini-tablet* in my daily life.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
BI3	I plan to continue to use *smartphones* frequently. I plan to continue to use *tablets/mini-tablets* frequently.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
FREQUENCY OF USE OF MOBILE DEVICES			
	Please choose your usage frequency for the following: *Smartphone*	7 point Likert Scale; 1=Never and 7=Many times per day; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of

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			technology. *MIS Quarterly*, 36 (1), 157-178.
	Please choose your usage frequency for the following: *Tablet*	7 point Likert Scale; 1=Never and 7=Many times per day; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
	Please choose your usage frequency for the following: *Mini-Tablet*	7 point Likert Scale; 1=Never and 7=Many times per day; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
	Please choose your usage frequency for the following: *Wearable*	7 point Likert Scale; 1=Never and 7=Many times per day; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
	I want to continue using my *mobile devices* rather than discontinue *their* use.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Bhattacherjee, A. (2001). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems*, 32(2), 201-214.
	My intentions are to continue using my *mobile devices* rather than any alternative means.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Bhattacherjee, A. (2001). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems*, 32(2), 201-214.

ID	Adapted Question	Scale	Original Article Citation
	If I could, I would like to discontinue use of my *mobile devices*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Bhattacherjee, A. (2001). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision Support Systems*, 32(2), 201-214.
CONTROL, EXPERIENCE SPECIFIC & DEMOGRAPHIC VARIABLES			
	Computers make work more interesting.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Jarvenpaa, S. L., Tractinsky, N., Saarinen, L. & Vitale, M. (1999). Consumer trust in an Internet store: A cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 1-35.
	I enjoy interacting with computers.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Jarvenpaa, S. L., Tractinsky, N., Saarinen, L. & Vitale, M. (1999). Consumer trust in an Internet store: A cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 1-35.
	Working with computers is fun.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Jarvenpaa, S. L., Tractinsky, N., Saarinen, L. & Vitale, M. (1999). Consumer trust in an Internet store: A cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 1-35.
	I use computers for fun.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Jarvenpaa, S. L., Tractinsky, N., Saarinen, L. & Vitale, M. (1999). Consumer trust in an Internet store: A cross-cultural validation. Journal of Computer-Mediated Communication, 5(2), 1-35.
	Do you own or use any *mobile devices* (smartphone, mini-tablet, tablet or wearable)?	Yes or No	For demographic/survey purposes

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	Which ones and how many of each?	Select from list and enter number	For demographic/survey purposes
	The use of *mobile devices* has become a habit for me.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
	I am addicted to using *mobile devices*.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
	I must use *mobile devices.*	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
	Using *mobile devices* has become natural to me.	7 point Likert Scale; 1=Strongly Disagree and 7=Strongly Agree; retained as original	Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.
	What is your age?	User provided number	Randolph, A. B. and M. M. Moore Jackson (2010). "Assessing Fit of Nontraditional Assistive Technologies." ACM Transactions on Accessible Computing 2(4): 1-31.

ID	Adapted Question	Scale	Original Article Citation
	What is your gender?	Male, Female or Intersex	Randolph, A. B. and M. M. Moore Jackson (2010). "Assessing Fit of Nontraditional Assistive Technologies." ACM Transactions on Accessible Computing 2(4): 1-31.
	I could complete the job using *mobile devices*…	Instructions provided with scale following	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	…if there was no one around to tell me what to do as I go	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	…if I had never used *a mobile device* like it before	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	…if I had only the manuals/*instructions* for reference	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	…if I had seen someone else using it before trying it myself	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.

ID	Adapted Question	Scale	Original Article Citation
		No	
	…if I could call someone for help if I got stuck	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	…if someone else had helped me get started	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	…if I had a lot of time to complete the job for which the *mobile device* was provided	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	…if I had just the built-in help *feature* for assistance	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	…if someone showed me how to do it first	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.

ID	Adapted Question	Scale	Original Article Citation
		Confident; else No	
	…if I had used similar *mobile devices* before this one to do the same job	10 Point scale if Yes, 1=Not at all confident; 5 = Moderately Confident; 10=Totally Confident; else No	Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19(2), 189-211.
	Do you feel limited in how you can use your current mobile device(s)?	Yes/No	For demographic/survey purposes
	Do you have any other comments to offer about mobile devices?	User provided comments	For demographic/survey purposes
	What is your major?	User provided response	For demographic/survey purposes
	What is your year in school?	User selects one of the following: Freshman, Sophomore, Junior, Senior, Graduate Student, Not Applicable	For demographic/survey purposes
	What is your annual household income? (If you live with your parents/guardians, please only include your income)	User provided entry (dollar figure)	For demographic/survey purposes