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MSc in Business Systems Analysis and Design
Project Report
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Tablets vs. Smartphones:
A Comparative Study Identifying User Satisfaction and Preference

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Declaration:
By submitting this work, I declare that this work is entirely my own except those parts duly identified and referenced in my submission. It complies with any specified word limits and the requirements and regulations detailed in the assessment instructions and any other relevant programme and module documentation. In submitting this work I acknowledge that I have read and understood the regulations and code regarding academic misconduct, including that relating to plagiarism, as specified in the Programme Handbook. I also acknowledge that this work will be subject to a variety of checks for academic misconduct.

Signed: Kelly Lynn Rogers

Acknowledgements:
I would like to thank all of the participants who have taken their time to be a part of this study. Without these individuals the research would not have been possible.

Furthermore, extraordinary thanks goes out to my advisor Jason Dykes who has provided me support and advise throughout the entire project. Without his guidance this research study would not be what it is today.

Abstract:
With the introduction of **tablets** into the marketplace many have speculated whether tablets would replace PCs as computing devices. From 2010, when the first generation iPad was released to the present day, tablets and PC's have grown to enjoy similar market shares (Gartner.com, 2014). Tablets have moved away from being seen as a competitor to PCs and are now being viewed as complementary devices (Clark, 2014). The next generation of speculation has moved away from computing devices to consider **mobile computing devices** and whether **smartphones** will replace tablets. This comparative study seeks to identify user attitudes toward smartphones by exploring how they are perceived within the mobile computing marketplace and determining if smartphones meet all mobile computing needs, and therefore promise to replace tablets. Through an **observational study** and user feedback, this study provides statistical analysis that confirms there are statistical differences in user preference for functionality on smartphones and tablets. Furthermore, it also affirms that smartphones possess the functionality to be a single mobile computing device. However, user preferences also suggest that both devices have a place in the market.

Keywords: Mobile Computing Devices, Tablet, Smartphone, Observational Study

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1.0 Introduction and Objectives

In 2010 Steve Jobs predicted that no one would want a phone with a big screen. With the successful launch of the iPhone 6 plus (Edwards, 2014) and the steady increase in the size of smartphones by Samsung and other smartphone manufacturers (Anon, 2014) it can be seen that this prediction has become obsolete due to shifts in the mobile computing market.

In 2007 the first iPhone, iPhone 1st generation, (appleinsider.com, 2014) was released and in 2010 the first iPad, iPad 1st generation, (apple.com, 2014) was released. Therefore, smartphones have seniority in the marketplace. However, tablets have been seen as mobile computing devices since their market inception while smartphones were originally viewed as extensions to PDA's (personal digital assistants) and only recently have they begun to be viewed as a full mobile computing device (MIT Technology review, 2013). Consequently, smartphones are newer to the market than tablets with respect to being full mobile computing devices. As of 2014, American smartphone usage was 58% and tablet usage was 42% (Pew Research Center's Internet & American Life Project, 2013). Likewise, as of 2013, smartphone and tablet usage in the UK was respectively at 53% and 32% (Office of National Statistics, 2013). These statistics demonstrate significantly high proportions of the population used both devices.

With a high proportion of users, the increase of Wi-Fi and 3G enabled technology and user expectations to be able to access information from any location; mobile computing devices have proven their place in the market (O'Toole, 2014). This study seeks to answer the research question: What are users' attitudes and perceptions of smartphones as a mobile computing device? The study also seeks to determine if smartphones meet all the mobile computing needs of their users, in turn, replacing tablets in the mobile computing market.

Refining the research topic still further, the study focuses on usability with respect to computing tasks being completed on smartphones and tablets for comparative analysis. Participants will complete tasks followed by questionnaires to measure their perception of items not limited to convenience, comfort level and mobility. Aspects of performance and completion style will be collected but user satisfaction and preference is the focal point of the research.

The hypothesis is that smartphones will outperform tablets concluding that smartphones will soon be the leaders in the mobile computing marketplace eventually replacing tablets.

1.1 Objectives

In 2008 Ozok et al. completed a comparative study concerning user satisfaction and preference between tablets and PCs. Much of the research in this study will use the methods set out by Ozok et al. but will move the research into the next generation to complete a comparative study of user satisfaction and preference between tablets and smartphones (2008). Due to feedback concerning the original research proposal and changes in the market, some aspects of the Ozok et al. study have been modified to increase the benefits of the results (2008). These aspects are fully discussed in the methods section of the study.

Utilizing the Ozok et al. research as a basic reference for methodology, the study takes the research to the next generation and aims to accomplish the following objectives: 1.) Identify users' attitudes toward smartphones. 2.) Distinguish how smartphones are perceived as a mobile computing medium. 3.) Establish the potential for smartphones to replace tablets (2008). Ozok et al. demonstrated that users enjoyed using tablets for many functions but they were not suited to replace PCs as a computing device. Thus this study concluded that PCs and tablets both have a place in the market (2008); which has proven to remain true in the time since the research has been completed.

1.2 Beneficiaries

With the increase of mobile devices in the marketplace it is becoming increasing challenging for end users, mobile app designers and developers and mobile computing device manufactures to keep up with the shifts in market needs. This research looks to benefit these user groups. It will benefit mobile device users by providing them with insight into whether they need both types of devices based on their usage requirements. It also will enable users to select the device that will best suit their functionality needs. Furthermore, the research will also benefit app designers and developers, as they will glean further insights into user preference on what functionality is best aimed at each type of device. This will not only benefit the app designers and developers but will enable them to create a more successful product, which in turn will also benefit end users.

Depending on the results of the research, mobile device manufacturers may also reap benefits from the research. If the research proves that smartphones meet all the functionality needs of users than future development can be focused on smartphones rather than tablets, enabling manufacturers to provide a wider product line within the specific device range. Furthermore, if the research proves that both devices meet the functionality needs of users, it provides insight to mobile device manufactures that there is a place in the market for both devices.

1.3 Project Selection

The project, as presented within the project proposal, set out to complete a comparative study to determine: '*Does country of origin or personality have a stronger impact on preference in web design?'* (Appendix A). As I possess a strong interest in user preference within digital technology, this was the initial topic chosen. During the initial research the iPhone 6 and iPhone 6 plus were launched and this sparked my interest in mid-sized mobile computing devices and their rise in popularity in the marketplace. This piqued my interest to such an extent that I revised my thesis topic, choosing to consider whether a single mobile device could meet all users needs in the market or if the need for multiple mobile computing devices will persist. The research took on a new perspective when I decided to focus on user preferences within digital technology. With the support of my advisor, I was able to revise the thesis to take on this new project initiative.

1.4 Project Plan

Due to changes in the project, I have included a modified ethics checklist, participant information document, and consent form as Appendices B, C and D. A modified project plan for the research can be found in Appendix E. The updated project plan covers the new scale of work of the thesis and the dates when tasks are to be completed. Basic completion dates and timelines are tracked within this project plan and updated dates of completion are covered. A risk register that has been updated to suit the modified project is included in Appendix F.

2.0 Context

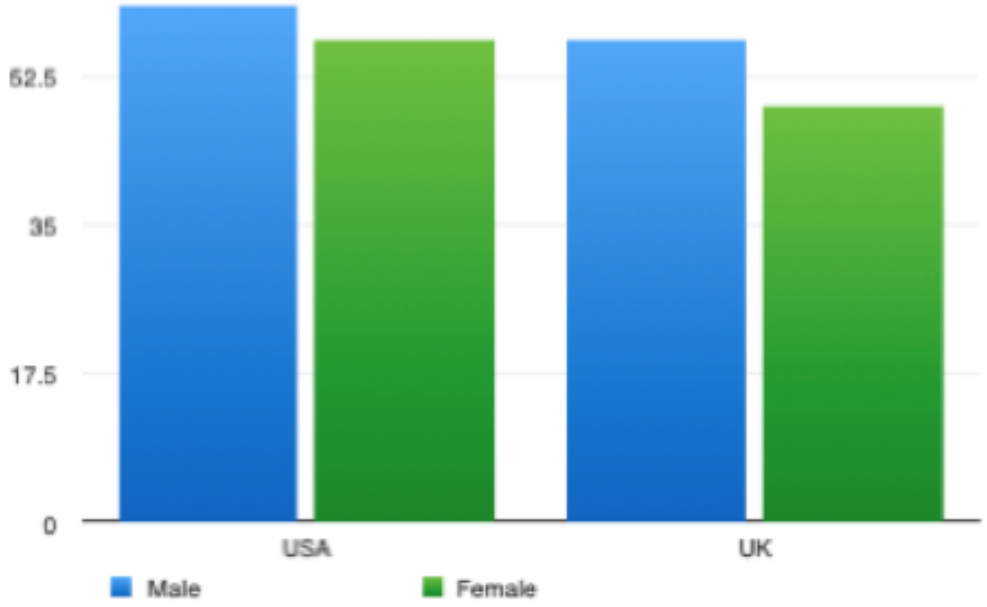
The original iPhone, first generation, is 115mm by 61mm (appleinsider.com, 2014) in comparison to the original iPad, which is 243mm by 190mm (apple.com, 2014). Therefore the surface area variance of the two devices is 39,155mm. The recently launched iPhone 6 plus is 158mm by 78mm in comparison to the recently launched iPad mini, which is 200 mm by 135mm. Thus the surface area variance between these two devices is 14,676 mm. Within this seven-year period, the surface area variance between tablets and smartphones has decreased from 39,155mm to 14,676mm for a total of 24,479mm. This suggests that options within the market have expanded and the two devices have models that have increased in similarity. This research uses Apple as the example but similarities can be seen in Samsung devices and the introduction of their versions of phablets (MIT Technology review, 2013). This generates the question whether a single device would meet users needs within the market. As one of the key functional drivers on smartphones is the standard ability to place phone call, which can be done on tablets only through VOIP (voice over internet protocal) capabilities, the assumption is made that if one device were to override the market it would be smartphones.

This research will take tablets and smartphones and compare their key functionality to determine their usability. This will support the research question which seeks to determine user attitudes and perceptions about smartphones as a mobile computing device and determine if smartphones meet all mobile computing needs of users. The study aims to distinguish the: who, what, where, when and why of users' interaction with smartphones and tablets.

2.1 Target Audience- Who uses mobile computing devices

The target audience of users is spread relatively evenly among common demographic statistics of gender and race. In the USA the gender spread of smartphone usage is: 61% male and 57% female (Pew Research Center's Internet & American Life Project, 2013). While in the UK 57% males and 49% females have smartphones (Office of National Statistics, 2013). Figure 1: Smartphone Usage by Gender and Region depicts these statistics below. Furthermore, the racial spread of smartphone users in the USA is 53% Caucasian, 59% African American, and 61% Hispanic (Pew Research Center's Internet & American Life Project, 2013). These statistics suggest that race also does not have a strong impact on mobile usage.

Figure 1: Smartphone Usage by Gender and Region data from (Office of National Statistics, 2013) and (Pew Research Center's Internet & American Life Project, 2013).



Though gender and race do not have a significant impact on usage rates, age does play a role in terms of mobile device usages. Young adults are currently the leading contributor of device usage (Smith, 2011). Seniors are currently the group with the lowest levels of wireless Internet usage. Eight in ten seniors (those ages 65 and older) are either internet users who do not go online wirelessly (24%) or do not go online at all (56%) (Smith, 2011).

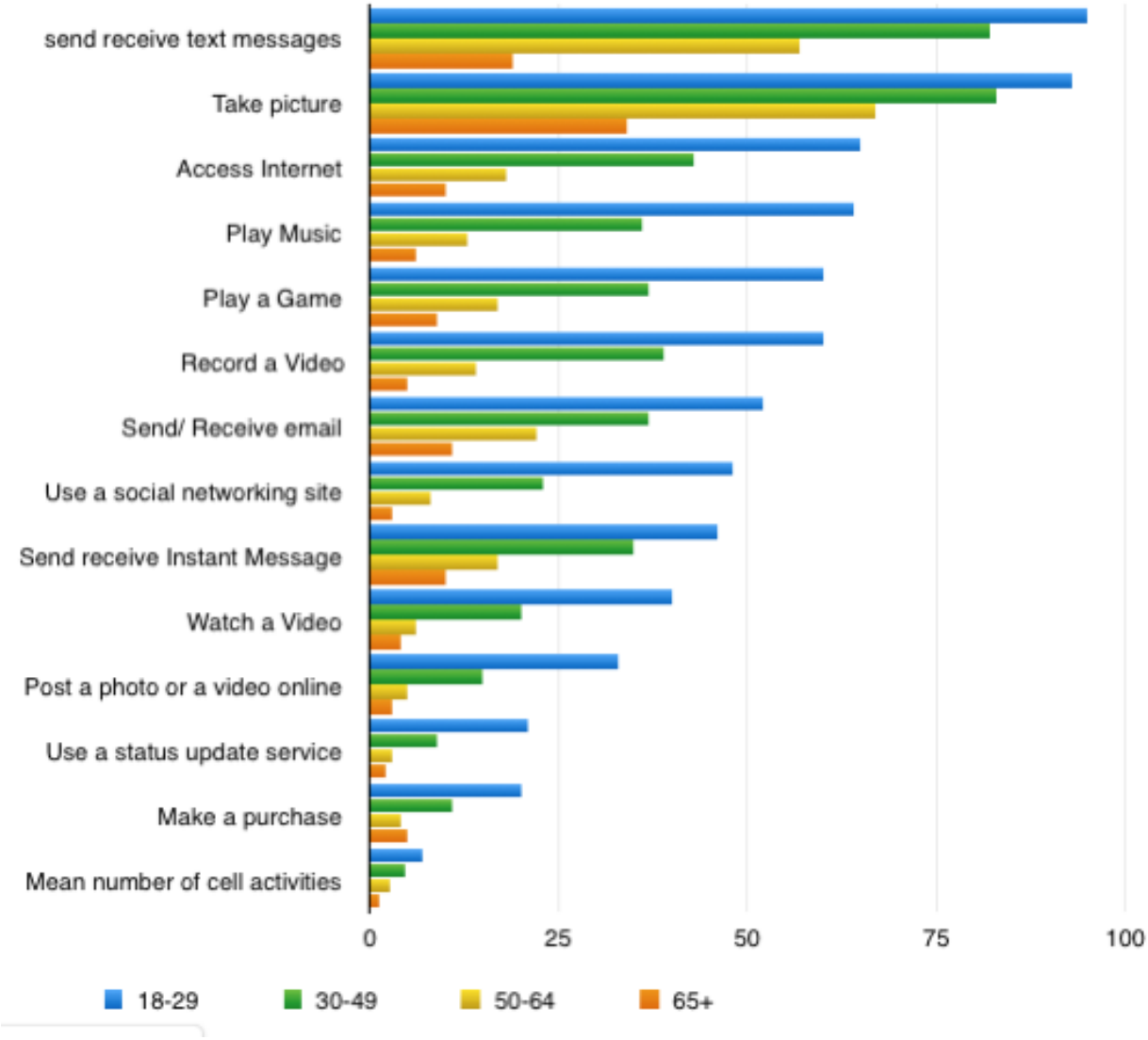
2.2 Functionality Drivers- What functions are used on mobile computing devices

Functionality of mobile devices has a range of drivers. Several studies confirm that communication is the key function that mobile devices provide for their users (Cui and Roto, 2008). Communication includes written and voice, with voice including standard calls and web-enabled calls through platforms such as Skype or Viber.

With respect to written communication, studies have shown that the average reading rate on printed formats is approximately 235 words per minute (Just & Carpenter, 1980) in comparison to the average reading rate on mobile devices, which is approximately 223 words per minute (Biedert et al 2012). Such a small variant suggests that the ability to consume data on printed format or mobile device differs a small degree only. Font size has proven to have no real impact in terms of speed of consuming literature (Beymer et al, 2008). However, research has found that increasing font size 20% increases the need to scroll to 42% for medium to large size font and 119% for small to large font (Schildbach & Rukzio, 2010). The more a user has to scroll within a document, the slower the speed at which they can consume information. A study has proven that slower reading rates were found when users encountered less characters per line, since the amount that they had to scroll was increased (Dyson and Haselgrove, 2001). Therefore, the text size itself may not have a direct impact on users' reading pace but it impacts the amount of scrolling required by users, which in turn impacts reading speeds on devices.

Research completed by Smith identifies common functionality on mobile device with respect to age groups. Figure 2: Mobile Device Usage by Age Group shows the results of the study, which included 1,009 participants (2011).

Figure 2: Mobile Device Usage by Age Group: redrawn from (Smith, 2011).



As can be seen from the figure above, the younger two age groups have the most users in each category, between these age groups there is a mix of which group has the largest number of users. Within the mean number of cell activities, the youngest age group to the oldest are ranked as follows: (6.9), (4,7), (2.5) and (1.2). Thus, though different age groups may vary in top usage based on specific tasks, overall the functionality usage decreases within the age groups as presented (Smith, 2011).

2.3 Location- Where we use the mobile computing devices

With the portability and ease of use of mobile devices, visiting an app can occur in almost any location. Since mobile devices keep a fairly constant connection there is no standard requirement for a loading time that is seen with a PC making it easier to access (Barron, 2008). The average length of a visit on a mobile app is a minute and 11 seconds (Dundar and Akcayir, 2012). Since mobile devices are portable their usage can occur in any number of places; studies have reported that people use smartphones to fill time. This includes but is not limited to: waiting in lines in shops and during transportation. (Karlson et al., 2010). According to research by Adobe regardless of age users spend the most time on their mobile devices in the respective order: home, out and about, and work (Adobe, 2013). Studies have also proven that 85% of users felt mobile devices are a central part of everyday life (Marketing Cloud, 2014).

Though devices have the functionality to be used any it has been concluded that users use them most while stationary (Church and Oliver, 2011). However, stationary in respect to this study included a person sitting while on a train, standing while in line etc., which supports the above research in regards to staying connected in any location (2011).

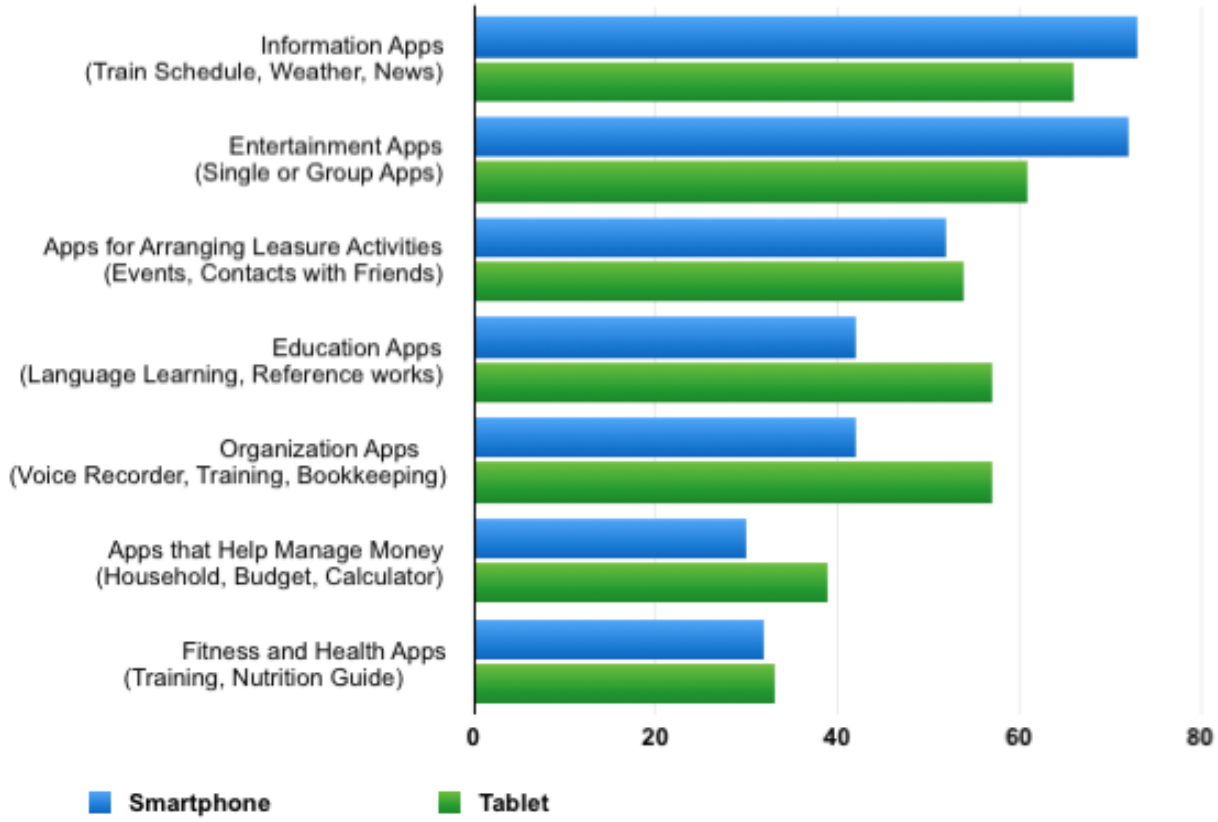
A four-month longitudinal study of mobile phone usage of teenagers determined that participants used the mobile devices very similar to PCs and even when users had access to PCs mobile devices were chosen (Rahmati and Zhong, 2010). Proving that mobile devices have their own niche in technology. Mobile devices not only offer a fairly constant connection but they offer mobile apps to directly link users to sites. Church and Oliver have found that more people use app versus phone's browsers to access information (2011). Further studies have concluded that 89% of mobile users believe their mobile device connects them to what is going on in the world (Marketing Cloud, 2014). This can be concluded being able to access the device in any location to stay connected with the world is a critical aspect of mobile devices.

3.4 Motivation- Why do we use mobile computing devices

Mobile devices have become more than a form of technology, they have become an accessory. "The choices that individuals make about their mobile phones reflect to themselves (and others) what they enjoy and engage with: the mobile phone is used to construct some aspects of their identity" (Peslak, Shannon and Ceccucci, 2011, pp409).

Furthermore, it has been proven that the type of app downloaded, and in turn used, varies according to the device used. As shown in Figure 3: App Downloads by Device (Mobile Internet, 2012), functionalities that require shorter periods of time (Information Seeking and Entertainment Apps) are used more frequently on smartphones, while tasks that take longer periods of time (Organizational Apps, Apps that Help Manage Money) are more suited for tablets.

Figure 3: App Downloads by Device Type: redrawn from (Smith, 2011).



2.5 Time- When do we use devices

According to Smith, more than half of those who use mobile devices access the Internet via their devices daily (2011). Furthermore, 58% of the users accessing the web on a smartphone did so for personal matters against 20% for work-related matters (Mobile Internet, 2012). This indicates that for users with standard schedules, devices are used most often during nights and weekends. Similarly, 65% of tablet owners report using their tablet while watching TV at least once per day (Marketing Cloud, 2014). Studies have determined that users will access their smartphone device while shopping in order to access product information (Adobe, 2014). Furthermore, 37% of users ages 18-29 have utilized a mobile device while shopping to access product and brand information. Studies also have concluded that participants utilize apps on mobile devices during work out sessions to track distance and time of work out session (Kranz et al., 2013), supporting evidence that mobile devices are used on personal time.

Mobile devices are also growing in usage as an educational platform, to be used during school. A study of elementary school students by Dundar and Akcayir demonstrated that allowing children to read off of mobile devices rather than from textbooks provided enhanced benefits as it allowed children to increase the font size of text as needed (2012). The study also suggested that mobile devices have an advantage over standard textbooks, as they are easier for children to carry (2012).

3.0 Methods

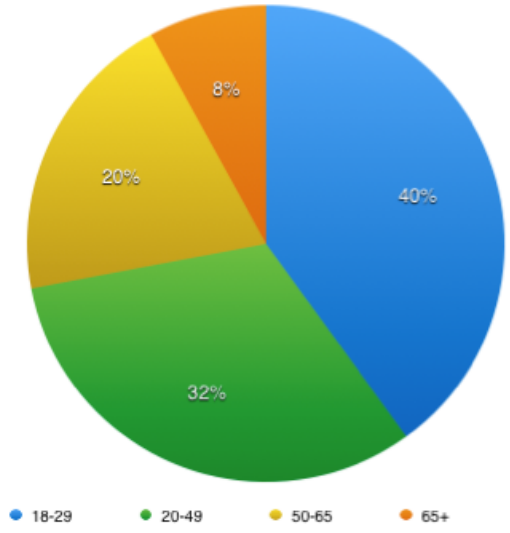
The majority of current research on mobile device usability focuses on mobile devices compared to PCs. The research conducted within this study moves into the next generation to focus specifically on usability between different mobile devices. To gather detailed insights in a field with limited specific research, an observational study was completed (Oates, 2008). The research within this study will follow the same four tasks as those employed within the study 'A Comparative Study Behavior Between Tablet and Laptop PCs: User Satisfaction and Preference' (Ozok et al, 2008) with slight variations to account for specific functionality drivers of mobile devices.

The first aspect of the research is an observational study. Four tasks are completed within this study; the tasks consist of reading, writing, screen manipulation and utilizing the camera. In the Ozok et al. study, form filling was the fourth task (2008), but this has been updated to adjust for commonly completed mobile tasks (Smith, 2011). The second aspect of the study is a user satisfaction questionnaire. Different questionnaires will be completed following the completion of each task on both the smartphone and tablet, and again at the end of the study. During the trial, notes were taken by the observer to identify possible key trends; this is not be the focal point of the research as the research is centered on user preference. This information is used to support data themes that were observed during tasks completed by users. Each task and supplemental questionnaire is discussed in full within its respective sections.

3.1 Participants

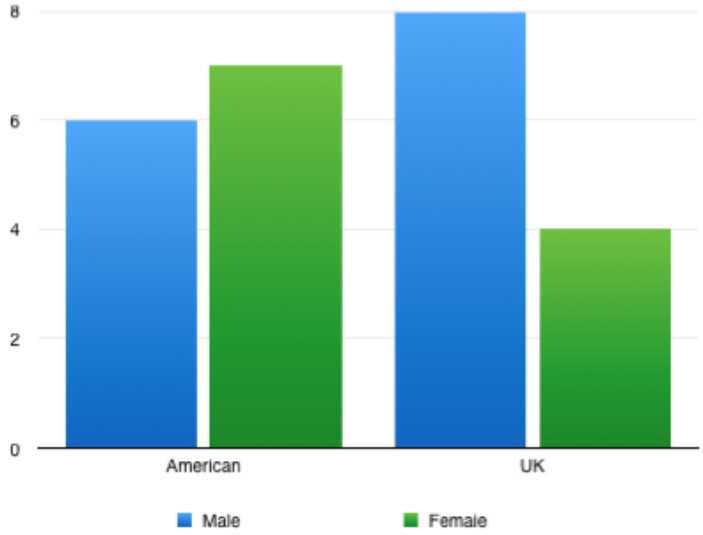
The study included 25 participants. In order to secure the privacy of participants they are referred to 'p' and then the participant number throughout the study. The age range and demographics used were modeled to follow the target market as identified by Smith (2011). Within Smith's study, age had the largest impact on mobile device usage and the sample size within this study is chosen to model the population of users. No participant under the age of 18 was used in this study. Therefore, the sample size used within the study covers a varied percentage from each age range with a minimal number for the 65 older group including: 40% 18-29 years, 32% 30-49 years, 20% 50-65 years and 8% 65 years or older. This represents the population of users that use mobile devices as discussed within the context section. Figure 4: Participants by Age Group displays the age groups used in this study.

Figure 4: Participants by Age Group



Furthermore, since individuals from America and the United Kingdom have similar usage (Pew Research Center's Internet & American Life Project, 2013 and Office of National Statistics, 2013) the proportions used within the study were kept fairly equal: 48% of the sample size is from the UK and 52% is from America. Similarly, gender was identified as having minimal difference, therefore both groups were represented 44% and 56% female to male respectively (Pew Research Center's Internet & American Life Project, 2013) and (Office of National Statistics, 2013). Figure 5: Participants Demographic Gender vs. Nationality is displayed below to show the sample size of the demographics used in the study.

Figure 5: Participant Demographics: Gender vs. Nationality



All participants selected for the study were chosen due to the fact that they have an iPhone and iPad. This effectively limited the variables in the study. All participants were chosen using convenience sampling (Oates, 2006). Though the sample is modeled to represent the user population, using convenience sampling may limit some varying factors including: participants' economic status, interests and background. Further impacts are discussed in full in the limitations section of the research.

3.2 Materials

The materials that participants used within the study include: iPad 2nd Edition, iPhone 5, pens, and printed literature. The iPhone 5 that is used has a height of 4.87 in, width 2.31 in, depth .3 in, and weight 3.95 ounces (Support.apple.com, 2014). The iPad 2nd edition that is used has a height of 9.5 inches, width 7.31 inches, depth of .34 inches, and a weight of 1.33 pounds (Support.apple.com, 2014). Pens were provided at the study for the participants to sign the consent form and complete the questionnaires. The printed materials given included: consent form, questionnaires for each task, final feedback questionnaire and a document with text for participants to complete the writing task.

3.3 Procedure of Study

Prior to the study participants were sent an email thanking them for their participation and informing them of the location and time to attend the study. They also received a copy of the Participant Information Form (Appendix C). This allowed participants the opportunity to review the document and bring any questions with them to the study. Each participant was also informed that the study would not require any additional materials. For the convenience of the participants, the study was held at various locations. All environments used were safe, quiet, and comfortable to ensure that participants had a similar experience while completing their tasks. On arrival participants were greeted and asked whether they had any questions concerning the participant information form. Once questions were addressed, they were given the consent form to read and sign. A copy of the consent form is included in Appendix D. Once the consent form was signed the study commenced.

Users were asked to complete four tasks. Each task was repeated on each device, the tablet and smartphone, for a total of eight tasks. The order of tasks and the order of which device was given first was randomized to reduce learned affect by participants (Rogers, Sharp & Preece, 2011). After each task on each device was finished, a questionnaire was completed to collect user feedback. An additional questionnaire was also given for each device at the end of the trial.

The questionnaire used the likert scale ranges from 1-5 with 1 representing strongly disagree, 2 disagree, 3 neutral, 4 agree and 5 strongly agree (Oates, 2006). The majority of the questions were stated as positive attributes; i.e., I found the task easy to complete. While some questions in the study were stated in the negative tense to ensure participants were reading the question; i.e., I found the task difficult to complete. When participants answered the last question, their participation concluded, as they were not required to follow up in any way.

3.3.1 Task 1: Reading Task

To determine users' reading preferences on each device an article was presented to each participant on the smartphone and the tablet. To prevent learned effect, the reading tasks chosen were similar in length, about 200 words each, but differed in their content. Users were required to read an article on each device. Following the procedure by Ozok et al., the articles chosen were about computer networking (2008). Users were told at the beginning of the study that they might ask questions about the article following the task, this was done but ensured that participants were reading the entire article.

The reading questionnaire included a question on the portability of the device. Therefore, once participants started the reading task, they were asked to pick up and carry the device across the room and come back. Unlike the study by Ozok et al. participants completed the study in varied locations (2008). Therefore, the distance participants walked ranged from approximately 10 to 20 square feet. Though the distance was kept within a range it may have slight impacted the results. This is discussed in full within the limitations section of the research. Users were timed during the task to determine if there was a difference in the reading times on smartphones and tablets; the time spent walking prior to the task was not included in the time.

Following the task users were asked for their feedback via a questionnaire. The questionnaire below represent the one used following both the smartphone and tablet reading task. The numbering within the questionnaire was the same for each participant and correlated with the results presented in the results section later in the research.

Reading Task Questionnaire:
Please rate the following questions 1-5.
(1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree)
1-1 It was easy to complete the task on the device.
1-2 The screen had adequate brightness.
1-3 The screen size was good for the task.
1-4 I had a low number of errors completing the task.
1-5 The device is very portable.
1-6 The device has the ability to do casual reading.
1-7 I was able to perform task effectively on the device.
1-8 I was able to perform the task efficiently on the device.
1-9 Overall I am satisfaction with the reading task on the device.

3.3.2 Task 2- Writing Task

Within the writing task, users were asked to type an email on the iPhone and the iPad. In line with the procedures used by Ozok et al., in order to limit the variables users were given a specific document of approximately 100 words to be typed on each device (2011). Different sections of articles were given for each device so the content would not be memorized; both articles were again about computer networking (2011). During each test the user was given the print out of the text to type on each device. Users were timed during the task to calculate if there was a difference in speed of completion.

Following the writing task on each device, participants were given a questionnaire to collect their feedback on the task. The writing task included the following questions:

Writing Task Questionnaire:
Please rate the following questions 1-5.
(1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly Agree)
2-1. It was easy to type on the device.
2-2: I had no difficulty using my fingers for typing.
2-3: Overall I am satisfied with the writing/typing task on the device.
2-4: It was efficient to complete the task on the device.
2-5: It was effective to complete the task on the device.
2-6: It was difficult to type on the device.
2-7: I had a low number of errors completing the task on the device.
2-8: My finger was a convenient way to input text on device.

3.3.3 Task 3- Manipulation Task

The third task required users to manipulate the screen on each device. This included having participants close an app, open an app, zoom in to enlarge, zoom out to shrink and swipe to move through images. These tasks were based on the Ozok et al. study but modified to target manipulations specific to smartphones and tablets rather than PC's (2008). The modified manipulations were selected based on research by Kim et al. on Hand Grip Patterns on Mobile Devices Users to incorporate varied aspects of movement within the research (2006). Each participant was timed during the task to calculate average speed of the task for users on each device.

The questionnaire that followed the direct manipulation task on both the iPhone and iPad is included below:

> Direct Manipulation Questionnaire:
> Please rate the following questions 1-5.
> (1 Strongly disagree, 2 Disagree, 3 Neutral, 4 Agree, 5 Strongly Agree)
> 3-1. The task was easy to complete:
> 3-2: The device allowed me to complete the task efficiently.
> 3-3: I was able to easily able to perform the task.
> 3-4: The screen was responsive to my touch.
> 3-5: I had a low number of errors while completing the task.
> 3-6: I was inefficient in completing the task.
> 3-7: I am satisfied with device for completing the manipulation task.

3.3.4 Task 4- Camera

As with the Ozok et al. study, the fourth task was form filling (2008) but for this research paper this task was replaced with taking a photo to update the study with respect to specific mobile computing functionality. According to Smith, utilizing the camera to take a photo is the second most used function of mobile devices for both the 18-29 and 30-49 age range. This is second to reading and writing text messages (2011); the core functionality covered with task one and two.

For this task users were asked to open the camera and take two photos: one of an item in front of them and the second of themselves to utilize both the front and rear cameras on each device. The order in which the photos were taken varied for each device but the tasks remained the same for both the iPhone and iPad. Users were also timed to determine if there was a difference in the average time to complete the tasks on the smartphone compared to the tablet.

The questionnaire that users completed on the smartphone and tablet for the camera tasks is included below:

Camera Questionnaire:

Please rate the following questions 1-5.

(1 Strongly disagree, 2 Disagree, 3 Neutral, 4 Agree, 5 Strongly Agree)

4-1. The task was easy to complete:

4-2: The device allowed me to complete the task efficiently.

4-3: I was able to easily perform the task.

4-4: The quality of the pictures is good.

4-5: I had a low number of errors while completing the task.

4-6: I was inefficient in completing the task.

4-7: I am satisfied with the device for completing the manipulation task.

3.3.5 Final User Feedback

Following the completion of each of the four tasks, participants were asked to complete a final questionnaire about each device. Since users did not need to complete a task prior to completing the final user feedback questionnaire, participants were given the questionnaire and told to complete the questions with respect to a specific device. The device order given to participants was randomized. Directly after the questionnaire for one device was completed, the second questionnaire was given. Upon completion of the final user feedback questionnaire for each device, the participants were done with the study.

The questionnaire used for the final user feedback for both the smartphone and tablet was as follows:

Final User Feedback Questionnaire:

Please rate the following questions 1-5.

(1 Strongly disagree, 2 Disagree, 3 Neutral, 4 Agree, 5 Strongly Agree)

5-1. Overall Satisfaction with the device.

5-2: Tasks performed effectively on device

5-3: Overall easiness to carry the device.

5-4: Overall I performed well on the device.

5-5: Overall low number of errors on the device.

5-6: Overall I had high proficiency completing the tasks on the device.

5-7: I would feel comfortable completing all mobile computing tasks on this device.

5-8: This device was fun to use.

5-9: It is probable that this device meets all my mobile computing needs.

5-10: It is difficult to use this device.

5-11: The opinion of myself has improved while using this device.

5-12: I am satisfied with the amount of independent thinking involved with this task.

5-13: The devices are challenging to use.

5-14: The mental effort to use this medium is too high.

3.4 Data Analysis

Once the data was collected the analysis began. ANOVA tests were the primary analysis tool used to identify variance within this study. ANOVA tests were used to identify whether there were statistically significant differences in user preferences between the two devices, smartphones and tablets. The methodology used within the study was based on that of Ozok et al. (2008). Within this research, as only two variables were used, tablets and smartphones, a t-test could have provided the same results on significance. However, the ANOVA test was chosen to mirror the research of Ozok et al. as well as enable future research to be completed for a multi-factor ANOVA test. Additional research that can be build on this study is covered in full within the additional research section later on within this research. Stata, a statistical analysis software, was used to calculate the ANOVA tests.

As done within Ozok et al. a significance level of 95% was used (2008). Within the test this translated to a test score that had a p value of less than (.05). Any result that was under (.05) was deemed to have a significant difference. An ANOVA result with a statistical difference informed us that the users felt there was a difference in the devices used with respect to the user feedback question. Within the results section below these items are highlighted in bold to indicate the statistical difference.

Within the results section below, an analysis of the results is provided for each task. The full results for each task are presented in Appendices G-K. Copies of all the participants' questionaries' are included in Appendix L for reference. Furthermore, a copy of each participant's consent form is included within Appendix M but the name has been blocked out to protect participant's privacy.

4.0 Results

In order to test the layout of the tasks and questionnaires, a proof of concept study was completed prior to the study to determine potential issues participants might have in completing the study. Within the proof of concept a single participant completed the full study. From the proof of concept two changes were made from the original study. First, in the proof of concept study the iPad and iPhone each had a case. The iPad case was found to be bulky and interfered with typing. Though no issues were found with the iPhone case within the proof of concept study both cases were removed during the study to ensure consistency. Secondly, the questionnaire originally had separate forms for each device stating iPad or iPhone for each question. This was changed to simply state device as the participant gave feedback that the wording device would be shorter clearer description. These changes were included in the methods section. The individual's questionnaire results are not included in the final results as they had a slightly varied experience then the rest of the participants.

4.1 Reading Task

The analyses of the results from the reading task are presented below in Figure 6: Reading Task Results. The characteristics presented correlate directly with the questionnaire covered in the previous section. The detailed results from the reading task are included in Appendix G and individual questionnaires are included in Appendix L.

The table displays the following information: 1.) The question number, which correlates to the numbers on the questionnaires 2.) The description, which provides a brief description of what the question asked. 3.) Tablet (m), which is the mean score for the question on the tablet. 4.) Tablet (σ), which is the standard deviation for the question on the tablet. 5.) Smartphone (m), which is the mean score for the question on the smartphone 6.) Smartphone (σ), which is the standard deviation the question on the smartphone. 7.) F score, which is used to measure the test accuracy of the question in respect to both the tablet and smartphone. 8.) P Score, which is the probability of obtaining the result for the question in respect to tablets and smartphones. 9.) N=is the number of participants in the study, 25 participants. This sequence is repeated in a table for each of the tasks.

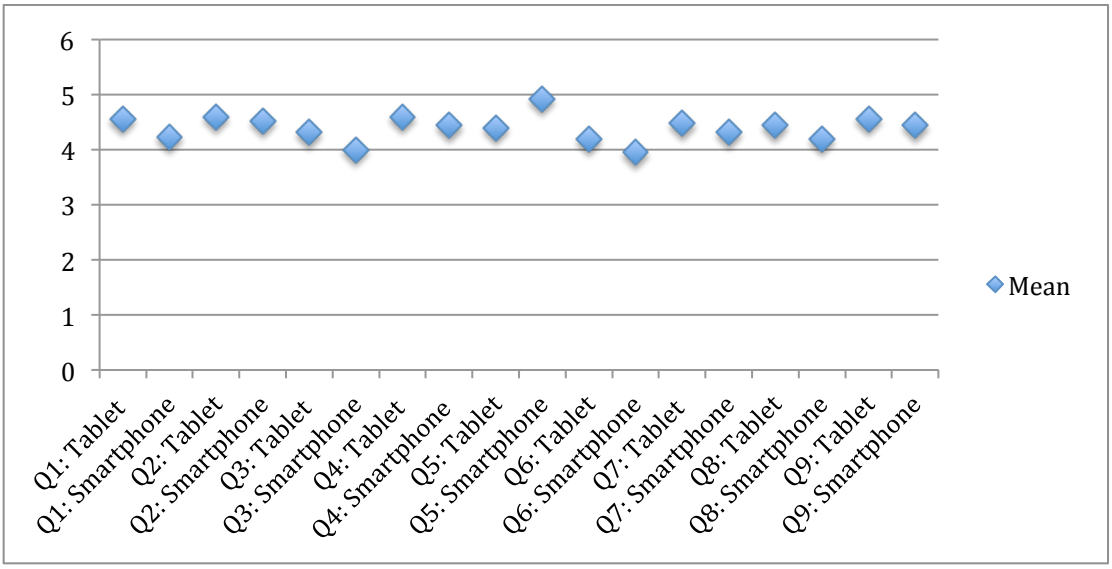
Figure 6: Reading Task Results

Question	Description	Tablet (m)	Tablet (σ)	Smartphone (m)	Smartphone (σ)	F	P
1.1	Ease of Task	4.56	.66	4.24	.86	2.30	.14
1.2	Screen Brightness	4.60	.63	4.52	.63	.19	.67
1.3	Good Screen Size	4.32	.79	4.00	.79	1.56	.22
1.4	Perceived low number of errors	4.60	.50	4.44	.49	3.38	.07
1.5	**Portability**	**4.40**	**.75**	**4.92**	**.75**	**10.20**	**.00**
1.6	Ability to complete casual reading	4.20	.94	3.96	.94	.68	.41
1.7	Perceived ability to complete task effectively	4.48	.79	4.32	.70	.60	.44
1.8	Perceived ability to complete task efficiently	4.44	.80	4.20	.80	1.15	.29
1.9	Overall satisfaction with the reading task	4.56	.57	4.44	.57	.43	.52
1.10	Speed of completion	64.3	3.28	64.34	3.28	.01	.94

n= 25 **bold**=statistically significant

As Figure 6 indicates, the only task that had a statistical difference in terms of user preference within the reading task was portability. The smartphone was ranked higher within this category indicating that it has the easier portability between the devices. Speed of completion showed no statistical significant difference; therefore any difference in the speeds are inconclusive and do not have a significant impact. However, due to the fact that every question with a reading task, except for the question with a statistical difference, scored higher for tablets, more research in this area is needed to determine if there is preference for tablets even if not by a statistical difference. Further research within this area is needed to determine if users display a higher preference for tablets with respect to reading in these categories or if the higher mean within all categories truly indicated a significant difference. The research is discussed in full in the Feature Research section later in this paper.

Figure 7: Reading Task Distribution



The distributions of scores for the reading task are displayed in Figure 7: Reading Task Distribution. The blue diamond represents the mean for each question. The results for each question on each device for the reading task are displayed. The responses for each of the questions, on each device, are displayed next to one another to enable an easy comparison. It can be seen that the results are skewed higher than a normal distribution, which may present limitations to the results; this is discussed in full in the Study Limitations section further on within the research.

Figure 8: Reading Task Speed of Completion

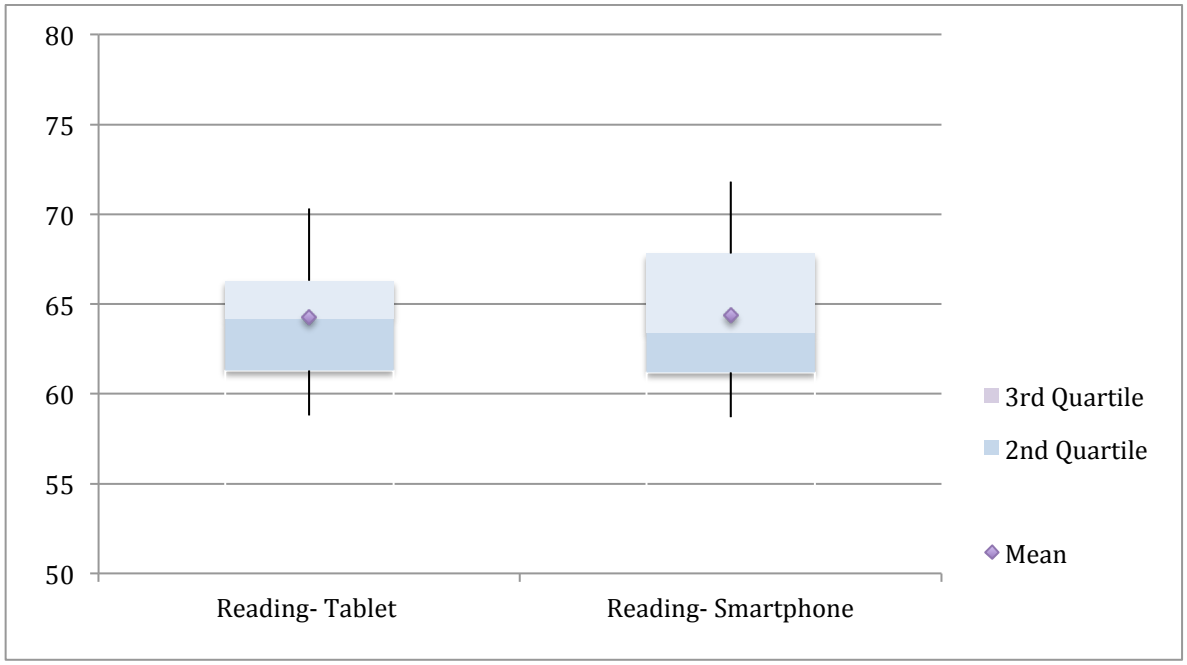


Figure 8: Reading Task Speed of Completion displays the speed of completion for the reading tasks on the tablet and smartphone. The light blue represents the 3rd quartile (75% percentile), the darker blue represents the 2nd quartile (25% percentile), the purple represents the mean, and the black line represents the minimum and maximum value. The same legend will be used throughout the research. It can be seen that on each device that the distribution is fairly normal for each of the tasks. Furthermore, the mean score and the outliers for each of the tasks are very similar and therefore no significant difference was found in the speed of completion.

4.2 Writing Task

The results from user feedback questionnaires for the writing task are presented in Figure 9: Writing Task Results. The full results for the writing task on the tablet compared to the smartphone are included in Appendix E. The same tablet format that is used in the reading task is repeated within the format in the writing task.

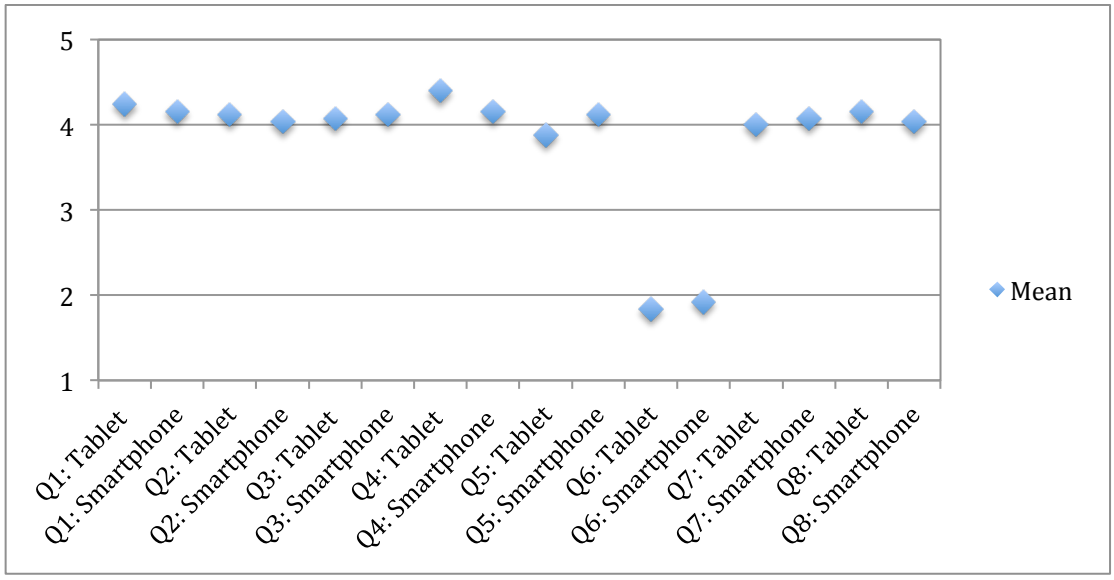
Figure 9: Writing Task Results

Question	Description	Tablet (m)	Tablet (σ)	Smartphone (m)	Smartphone (σ)	F	P
2.1	Ease of task completion	4.24	.86	4.16	.77	1.20	.73
2.2	No difficulty using finger	4.12	.64	4.04	.77	.15	.70
2.3	Overall satisfaction with the writing task	4.08	.98	4.12	.63	.05	.83
2.4	Perceived ability to perform the task efficiently	4.40	.53	4.16	.50	1.79	.19
2.5	Perceived ability to complete task effectively	3.88	1.08	4.12	.59	2.00	.16
2.6	Difficult to use finger to complete	1.84	.75	1.92	.55	.25	.62
2.7	Perceived low number of errors	4.00	.60	4.08	.63	.19	.67
2.8	Finger is a convenient way of text input	4.16	.70	4.04	.67	.39	.54
2.9	Speed of completion (Seconds)	261.84	3.55	265.83	39.29	.26	.62

n= 25 **bold**=statistically significant

The results display that there is not a statistical difference in user preference in any of the writing tasks completed on the smartphone and tablet. This includes question 2.6, which is stated in a negative context so the lower scorer marks the task with a higher preference. It also suggests that the speed of completion on each device did not exhibit a statistical difference. Furthermore, the questions that do not display a statistically significant difference are split between both devices. Thus user preference with respect to writing (typing) on mobile devices is the same for smartphones and tablets.

Figure 10: Writing Task Distribution



The distribution for the writing task is displayed within Figure 10: Writing Task Distribution. It can be seen that question 6 was asked in a negative context therefore, the result display much lower for this item. Furthermore, the distribution of the writing task is fairly normal but similar to the reading task it does have a skew to the higher end of results, which may have an impact on the results. This is discussed further on within the study with the Study Limitations section.

Figure 11: Writing Task Speed of Completion

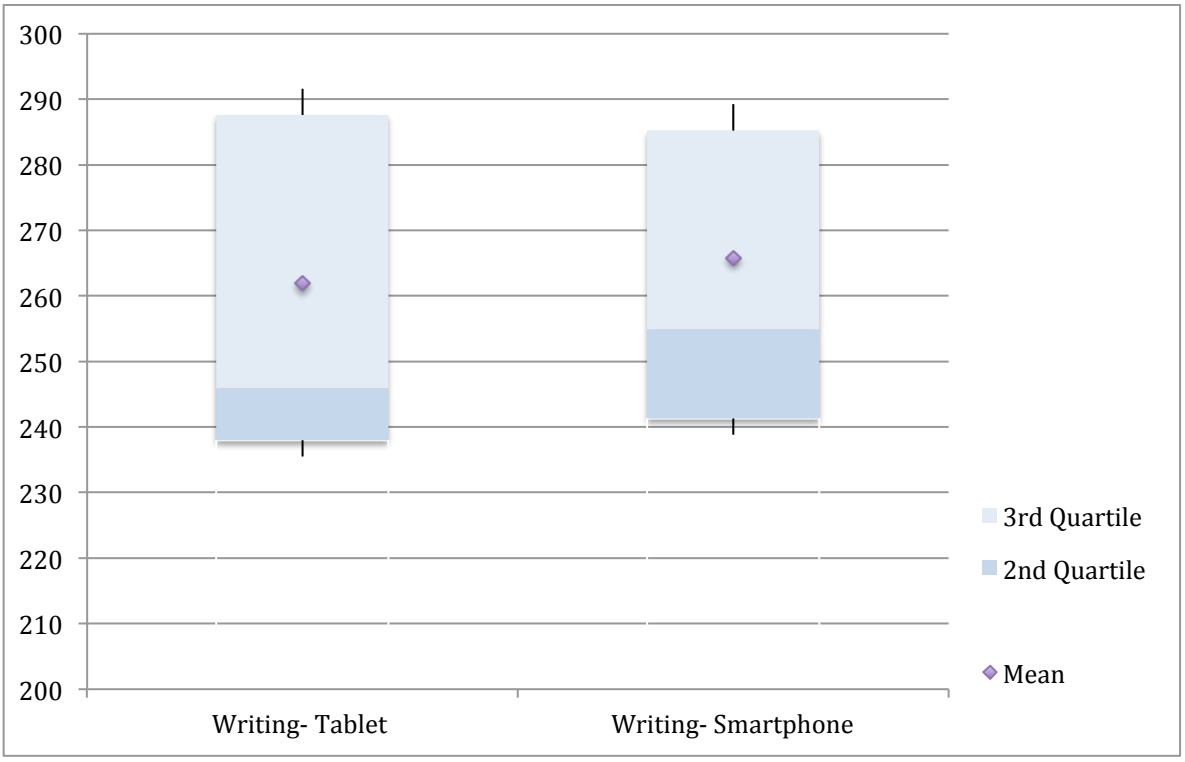


Figure 11: Writing Task Speed of Completion displays the speed of completion for the writing task on each device, tablet and smartphone. The writing task took users the largest amount of time to complete and also has the highest spread of time ranges to complete. The results for the writing task on average took longer to complete on the smartphone. However, the highest completion task for all users on each device was had on the tablet. Even with variation in the completion times it can be seen that overall the completion time is fairly similar which is confirmed by the fact that there is not a statistical difference in completion time.

4.3 Direct Manipulation

Figure 12: Direct Manipulation Results displays the analysis for user preference for smartphones and tablets for the direct manipulation task. The full results for the direct manipulation task are displayed in Appendix F.

Figure 12: Direct Manipulation of Task

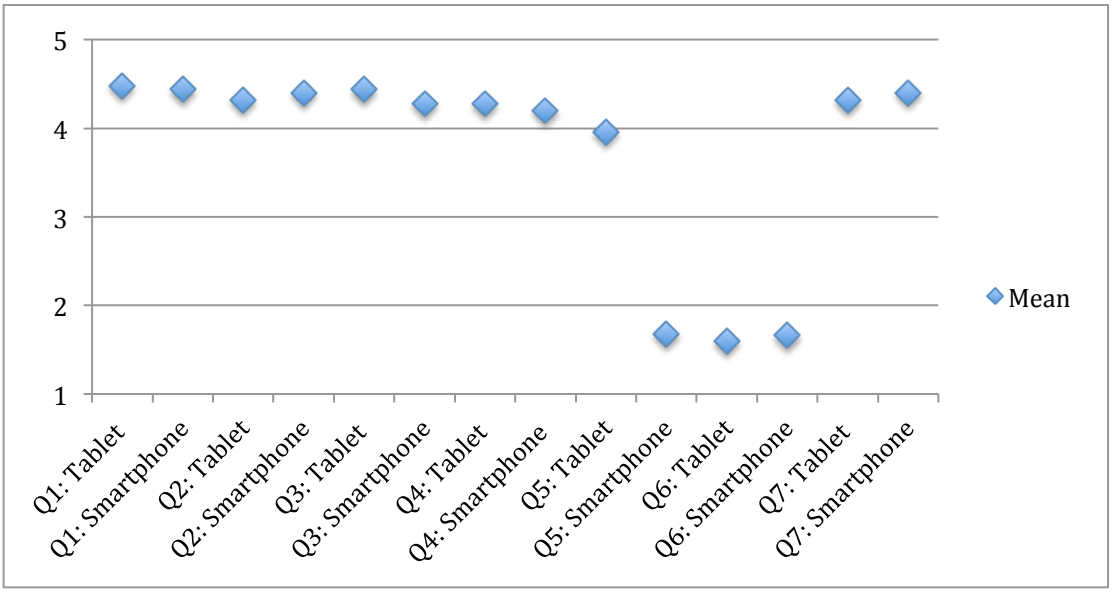
Question	Description	Tablet (m)	Tablet (σ)	Smartphone (m)	Smartphone (σ)	F	P
3.1	Ease of task	4.48	.57	4.44	.70	.05	.83
3.2	Perceived ability to perform the task efficiently	4.32	.55	4.40	.69	.20	.66
3.3	Perceived ability to perform the task effectively	4.44	.57	4.28	.72	.73	.40
3.4	**Responsiveness of screen**	**4.28**	**.45**	**4.64**	**.48**	**7.20**	**.01**
3.5	Perceived low number of errors	4.20	.57	3.96	.72	1.65	.21
3.6	Perceived inefficiency	1.68	.62	1.60	.75	.16	.69
3.7	Overall satisfaction within the manipulation task	4.32	.62	4.40	.57	.22	.64
3.8	Speed of completion	22.56	1.49	22.38	1.45	.19	.67

n= 25 **bold**=statistically significant

The analysis proves that there is a statistical difference in user preference in terms of screen responsiveness for the two devices. The smartphone is deemed to have a stronger response rate than that on the tablet. Both devices technically have the same response rate therefore it can be inferred that the difference in results may be due to familiarity with the device causing the device to be deemed less responsive or the greater surface area may cause the user to believe a greater manipulation is needed to complete the task.

The smartphone scored higher on four of the seven tasks listed. This includes question 3.6, which is written in a negative response metric making the lower score the preferred method. As the spread of questions is split between both devices it can be concluded that for the questions that do not have a statistical difference there is no difference in user preference between the devices with respect to direct manipulation on the platforms.

Figure 13: Direct Manipulation Distribution



Within Figure 13: Direct Manipulation Distribution the distribution of the responses for each of the questions on the smartphone and tablet are displayed. Within the responses of question 4 it can be seen that the average scores differ greatly from one another. This is supported by the fact that this question was proven to have a statistical difference in preference on each device. Question 6 can be seen to be written in a negative context and therefore has answers that are much lower then the rest of the responses. The distribution within the figure can be seen as skewed higher than a normal distribution, which may have an impact on the results, which is discussed later on within the research.

Figure 14: Direct Manipulation Speed of Completion

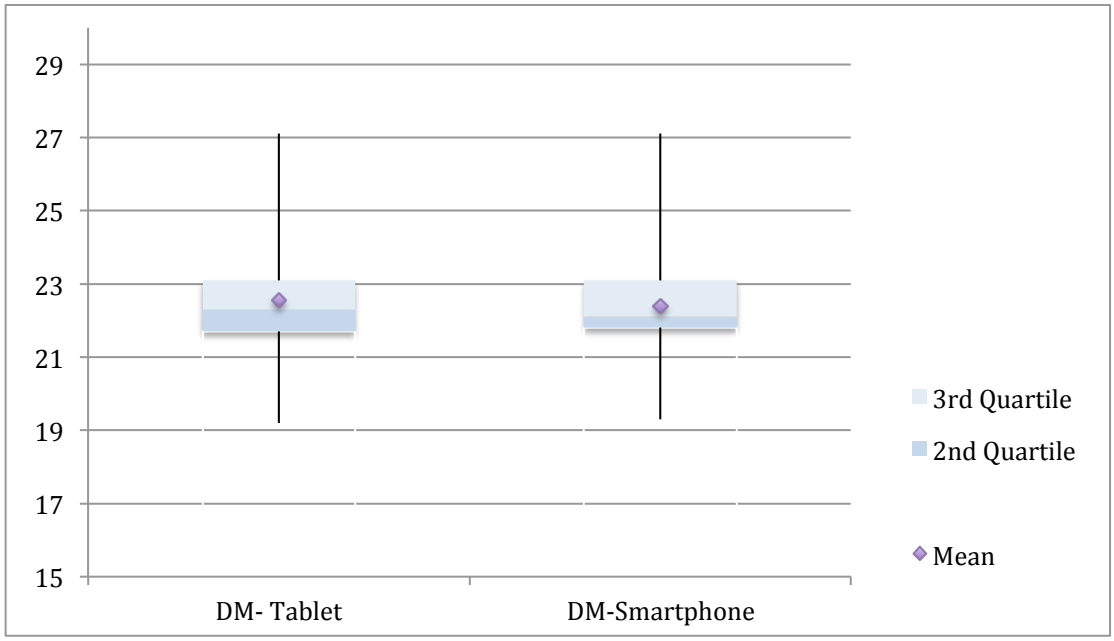


Figure 14: Speed of Completion displays the speeds of completion for the direct manipulation task. As the task took participants a short amount of time to complete there is a very small difference in the average time to complete each task. The outliers within this task proved to have a higher variance from the mean than other tasks. The same participant gave the maximum time for each device, which was much higher than the average. This proves that participants competency with mobile computing devices has more of an impact on the speed of completion than the device itself. Supporting the above graphic that the time to complete is very similar no statistical difference was found in the speed of completion for the direct manipulation task.

4.4 Camera

The statistical analysis for user preference for the camera (taking photos) task is provided within Figure 9: Camera Results. The full table of participants' results are included in Appendix I.

Figure 15: Camera Results

Question	Description	Tablet (m)	Tablet (σ)	Smartphone (m)	Smartphone (σ)	F	P
4.1	**Ease of Task**	**4.48**	**.75**	**4.88**	**.33**	**8.82**	**.01**
4.2	Perceived ability to perform the task efficiently	4.32	.82	4.40	.59	0.20	.66
4.3	Perceived ability to perform the task	4.44	.80	4.48	.57	.06	.81
4.4	**Perceived quality of image**	**4.28**	**.45**	**4.64**	**.43**	**7.2**	**.01**
4.5	**Perceived low number of errors**	**4.20**	**.47**	**4.76**	**.43**	**14.98**	**.00**
4.6	Perceived inefficiency	1.68	.98	1.60	.69	.00	1.00
4.7	Overall satisfaction with the manipulation task	4.32	.60	4.44	.57	.49	.49
4.8	**Speed of completion**	**18.38**	**.82**	**17.88**	**.83**	**4.59**	**.04**

n= 25 **bold**=statistically significant

The camera (taking photos) task is the only task that proved to have several questions that had statistically significant results in terms of user preference. There proved to be a statistical difference in the following areas: ease of task, perceived quality of image, perceived low number of errors, and speed of task. In each of the questions, smartphones ranked as the device with the higher user satisfaction.

Through observational feedback during the task, it was determined that the larger size of the iPad made the tablet more challenging for participants to use. This can be concluded as the rational behind why the ease of task was ranked preferable on smartphones by a statistically significant difference. However, both tasks ranked above a four on the Likert scale stating that for each device, on average, participants ‘agree’ that the task was easy to complete. The smartphone therefore was ranked the easier of the two devices to use though neither device presented users with great difficultly.

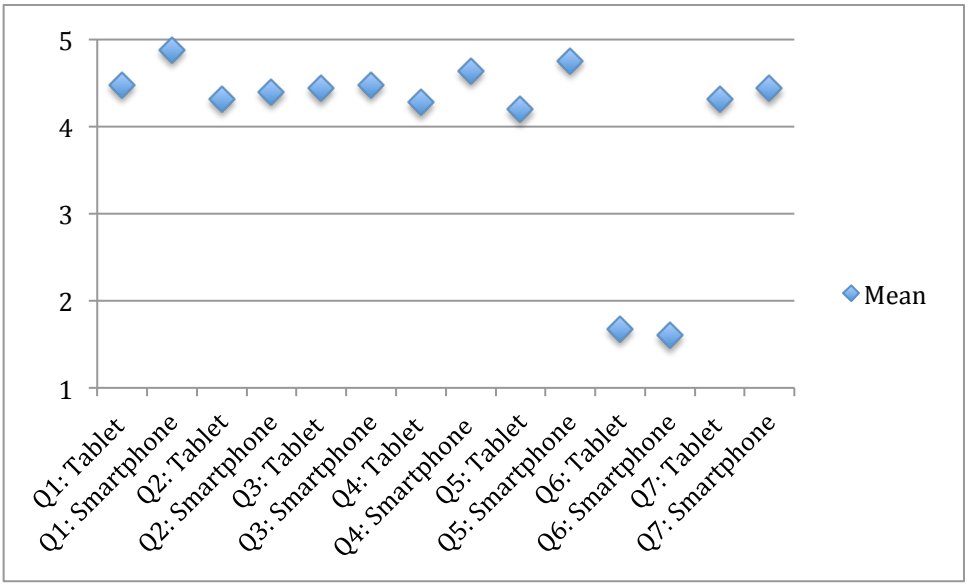
Users perceiving they had a low number of errors had a statistically significant difference; with perception being that completing the task on the smartphones resulted in less errors. All users were able to complete the task successfully; therefore, the real number of errors is lower than the perceived number of errors by users. It can be concluded that since the task was easier on the smartphone users also believed that they had less errors while completing the task.

The screen resolution exhibited a statistical difference that suggested smartphones have a higher resolution. However, the study proved that the results for this question are inaccurate due to the fact that the devices had a dissimilar resolution quality. It was shown that the iPhone 5 offers higher screen resolution than the iPad 2 used in the study; respectively 326ppi (apple, 2014) and 132ppi (Support.apple.com, 2014). As this is a limitation of the hardware within the study and does not provide accurate insight into user preference and perception of the devices the results are not included in the discussion. It is referenced within the future research section as an item that should be included in further research, as the smartphone and tablet selected need to have the same resolution so as not to impact results.

The camera task also exhibited a statistical difference with respect to the speed required to complete the task. On average it took users 18.38 seconds to complete the task on the tablet while it took 17.88 seconds to complete it on the smartphone. This was reflected in both of the other questions that were found to have statistical difference since the smartphone proved to be easier to complete which correlates to quicker speed. Furthermore, as discussed above the smartphone was perceived to have fewer errors, which also translates to faster completion.

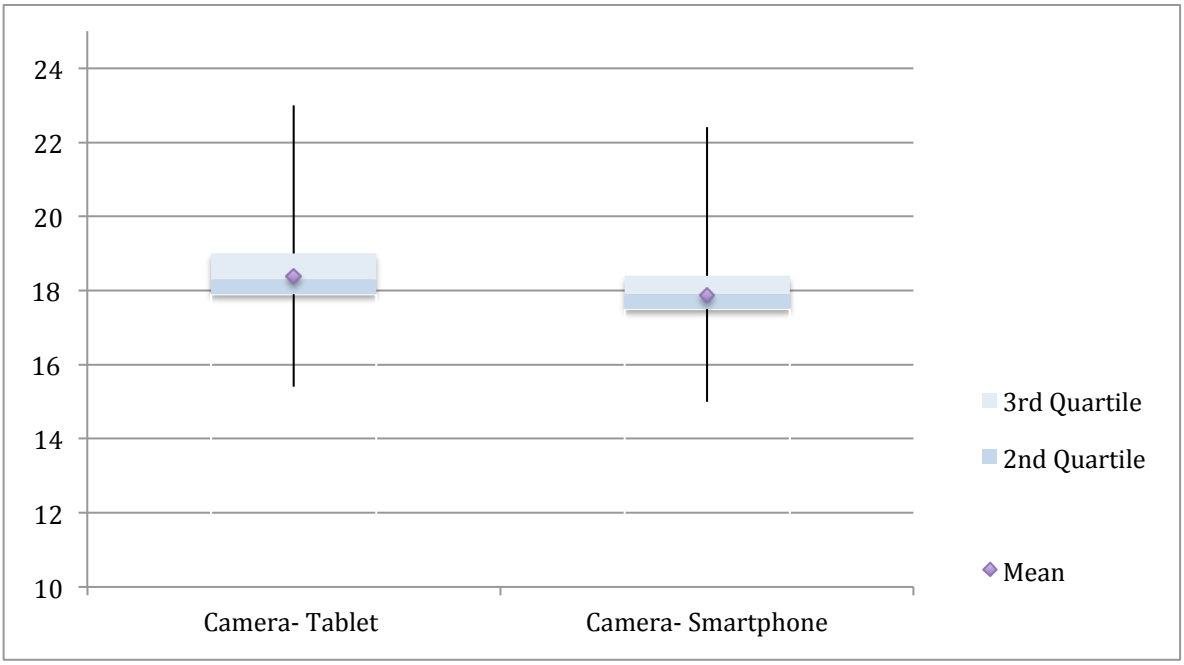
For the four remaining tasks that did not have a statistical difference, smartphones were ranked preferable in each of the categories. This includes task 4.6, which is noted in a negative context making the lower score the result with the higher user experience. Though all questions with a non-statistical difference shared the same outcome in terms of user preference, no additional research was needed as they support the findings of the questions with the statistical differences that the smartphone provided a better user experience with respect to taking a photo.

Figure 16: Camera Task Distribution



The distribution of answers can be seen in Figure 16: Camera Task Distribution. The camera task has more answers that have a statistical difference than any of the other tasks, which is represented within the distribution. It can be seen in questions 4.1, 4.4, and 4.5 have large differences within the means, which is supported by the fact that there is a statistical difference in preference between the devices. Question 6 is written in a negative context, which can be seen by the fact that it scored much lower than the other questions. As the results are more varied within the camera task the distribution is closer to being normalized then the other tasks but still is skewed to the high end. The potential impact of this on the results is discussed within the Study Limitation section of the research.

Figure 17: Camera Task Speed of Completion



The distribution of the speed of completion of the camera task is displayed in Figure 17: Camera Task Speed of Completion. The average time to complete the task is quite similar but as the variance of completion is very small it is proven to have a statistical difference in the time to complete. Furthermore, the outliers on the higher end are from the same participant on each device. The same participant that produced the higher times on the direct manipulation task also produced the outliers on the high end within the camera task.

4.5 Final User Feedback

The user feedback collected at the end of the study supports the research collected within each of the tasks throughout the study. Three elements were proven to have a statistically significant impact on user experience. These include: easiness to carry, comfort to use the device to complete all mobile computing needs, and probability that the device could meet all mobile computing needs. Each of these outputs confirmed that smartphones provide an enhanced user experience. Full outcomes are provided in Figure 18: Final User Feedback Results.

Figure 18: Final User Feedback

Question	Description	Tablet (m)	Tablet (σ)	Smartphone (m)	Smartphone (σ)	F	P
5.1	Overall Satisfaction	4.28	.60	4.20	.57	.24	.63
5.2	Tasks performed efficiently	4.56	.57	4.52	.57	.06	.81
5.3	**Overall easiness to carry the device**	**4.32**	**.55**	**4.84**	**.37**	**15.65**	**.00**
5.4	Overall perceived performance on device	4.24	.59	4.16	.67	.20	.67
5.5	Overall perceived low errors	4.36	.56	4.24	.65	.49	.49
5.6	Perceived proficiency on device	4.32	.65	4.24	.68	.18	.67
5.7	**Comfort to complete all mobile computing on device**	**1.64**	**.63**	**3.60**	**1.17**	**54.87**	**.00**
5.8	Device is fun to use	4.52	.57	4.44	.57	4.44	6.24
5.9	**Probable that the device meets all mobile computing needs**	**1.52**	**.50**	**4.32**	**.55**	**358.19**	**.00**
5.10	Difficult to use device	1.36	.56	1.48	.57	.56	.46
5.11	Opinion of self has improved while using the device	3.08	.56	2.96	.45	.70	.41
5.12	Satisfied by amount of independent thinking used on device	3.60	.49	3.64	.74	.05	.82
5.13	Device is challenging to use	1.64	.69	1.68	.84	.02	.84
5.14	Mental effort to use device is high.	1.60	.75	1.68	,68	.15	.69

n= 25 **bold**=statistically significant

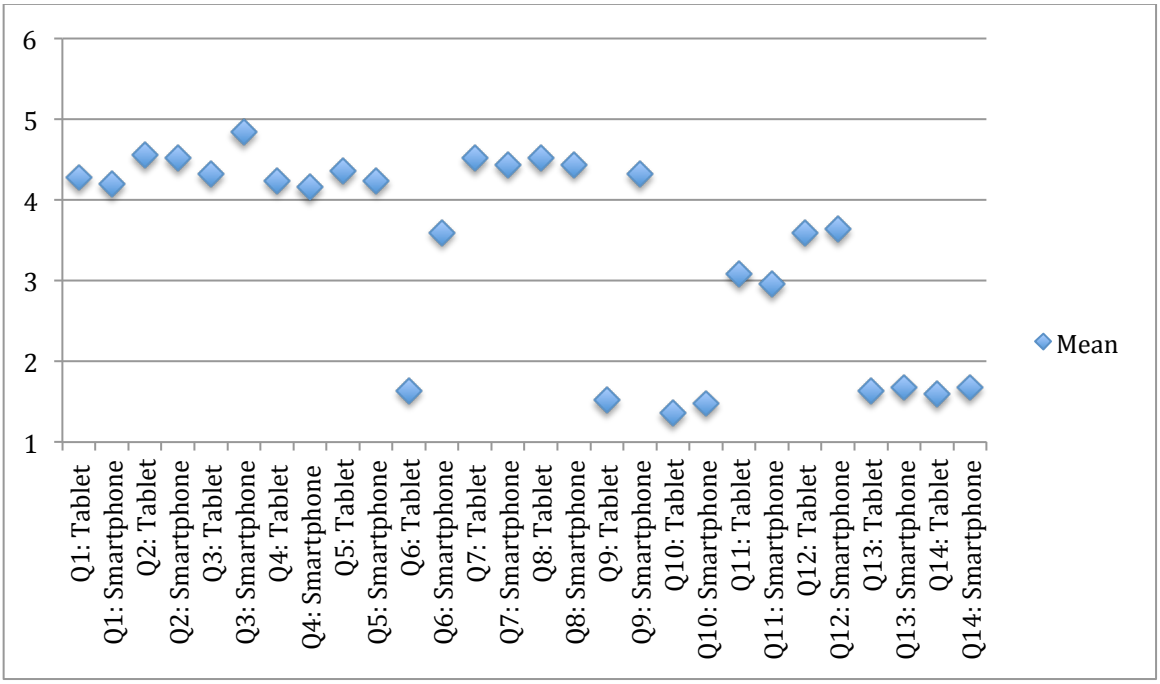
The overall ease with which the devices are carried exhibited a statistical difference, the smartphone scoring significantly higher. This supports the finding regarding task 1 in which smartphones were proven to be easier to carry by a statistical difference. Though smartphones scored significantly higher than tablets, tablets scored on average a 4.32, which suggests that users agree overall that they are easier to carry, even though they are not as easy to carry as a smartphone.

Comfort to complete all mobile computing on the device also displayed a statistical difference; users were more comfortable completing all tasks on a smartphone rather than a tablet. However, the average score that users were comfortable completing all tasks on their smartphone was on average a 3.6. Thus, the responses were just slightly above neutral.

Furthermore, the probability that they could complete all mobile computing on a single device was also proven to have a statistical difference. More users stated that smartphones could meet all their mobile computing needs over tablets. The probability of a smartphone being able to complete all users needs scored on average 4.32. This in comparison to the comfort to complete, as stated above, scored .72 higher on average. This can be translated to prove that many users feel that functionally a smartphone can meet all their mobile computing needs, they have a higher comfort level in using both devices.

Overall the tablet scored higher on 8 of the 14 questions. This included the three questions that were written from a negative perspective including numbers 5.9, 5.13 and 5.14. As the questions that did not have a statistical difference were split fairly evenly between the devices, it can be concluded that there is no difference in preference between smartphones and tablets for these questions.

Figure 19: Final User Feedback Distribution



The distribution of the scores for the smartphone task can be seen within Figure 19: Final User Feedback Distribution. It can be seen in the figure that 5-3, 5-7 and 5-9 have large difference in the mean score which supported the fact that a statistical difference is found for these questions. Question 5-7 displays that the only score connecting the preferences on the smartphone and tablet is an outlier on the low end for smartphone rating. For each of the individual questions data may be skewed however, overall the data within the Final Feedback Questionnaire is fairly normalized within its entirety.

4.6 Speed of Completion

The speed of completion by device had no statistical difference for the tasks except for the camera task, taking a photo, which was proven to be statistically quicker on the smartphone. Figure 11: Speed by Task Completion by Device displays the time comparison to complete each task. Though the camera task was proven to have a statistically significant difference in the time to complete between the smartphone and the tablet it can be seen in the graph below that even with the statistical difference overall there is a very low difference. This is due to the fact that the time needed to complete the tasks were very similar on each device, making the standard deviation low. When there is a low standard deviation within a data set then a statistical significant difference may occur even when the data sets have very similar mean (m) value.

Figure 11: Speed of Task Completion by Device

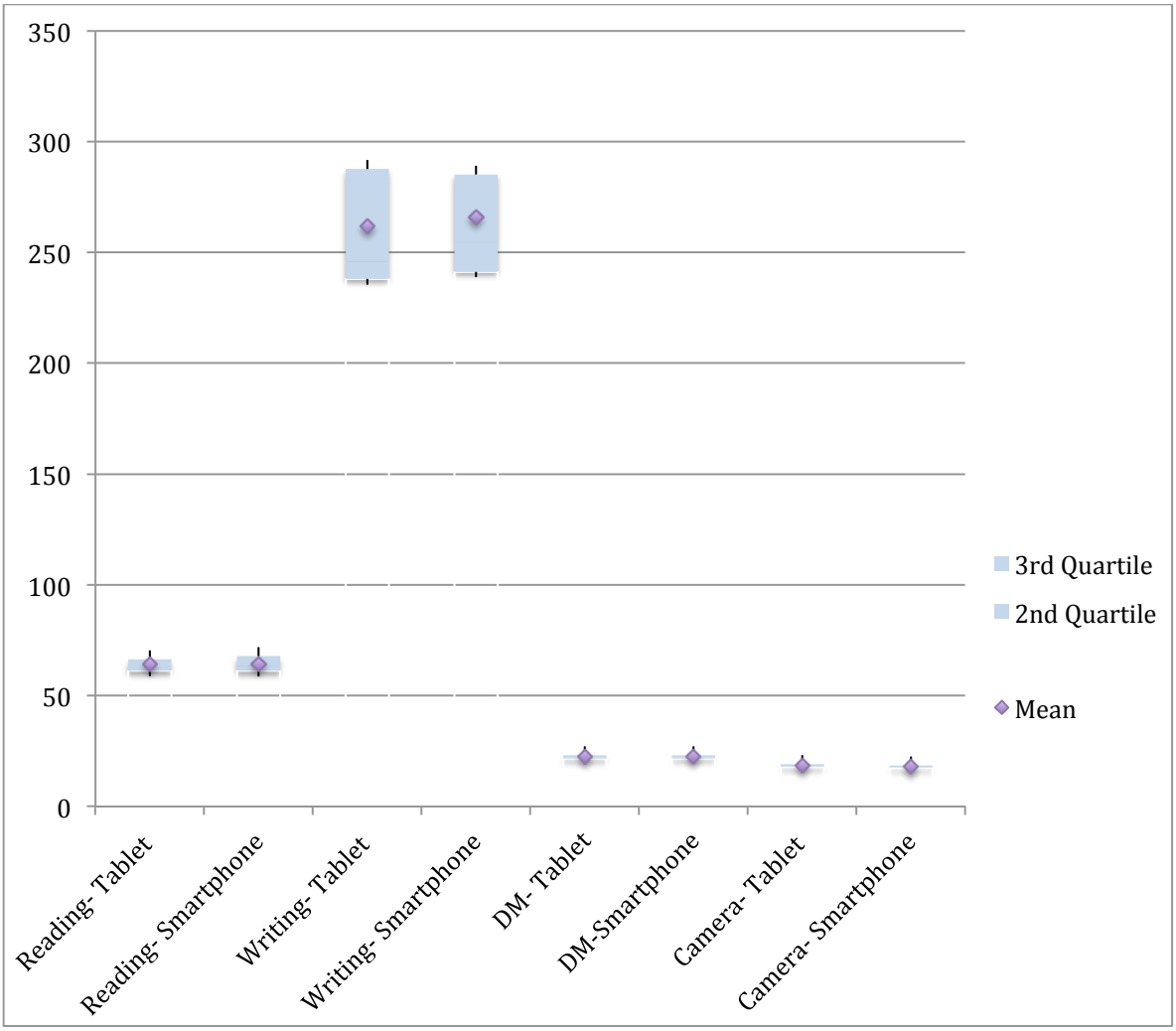


Figure 11: Speed of Task Completion by Device displays the rate of completion for each of the devices within a single graphic. Displaying the rates of completion within a single table displays a graphical representation of the overall time to complete tasks by device. Emphasizing that the writing task was a much longer task to complete than the other tasks. However, by displaying all the times of completion within a single figure much of the details for each of the tasks are lost as the scaling is spread over a greater distance.

5.0 Discussions and Reflections

The study has shown that, smartphones are generally perceived to have an enhanced user experience over tablets. Smartphones were also proven to provide a more complete functionality set than tablets. However, there are certain aspects of the tablet that provide an enhanced user experience. This section will interpret how the results from the study are linked to other studies, what the findings mean to users, and what can be concluded from this study.

5.1 Reading Task Results

The study found that smartphones display a statically significant difference in the preference for portability; proving smartphones provide the more mobile medium of the two devices. It has been proven that a key aspect of mobile devices is to ensure that they are portable for users; otherwise regardless of the number of features the device has, if it is not practical for users to incorporate into their lives, it will never be adapted into the mainstream market (Huang, 2009). Furthermore, according to Hemmet, the portability of a device is more than a physical construct but a way for users to expand their environment. For example, it may expand the office to the home or enable a family to connect all over the world (2009). Therefore, the portability of the device enables it to act as an extension of one self, connecting a person more deeply to the device (Hemmet, 2009). Regardless of whether a device is an extension of one self or not, it can be seen today that people access mobile devices from almost every location and therefore the portability of a device is a key functionality. Moreover, this study has shown that in this regard smartphones performed better.

Within the reading task, tablets were never ranked higher by a statistical difference but all scores that did not have a statistical difference ranked tablets higher. Though it was not a significant statistical difference, the fact that all items were ranked higher quantify rational for further investigation. Further research into reading on mobile device was looked into via a study by Biedert (2012). The study looked into reading patterns on Android phones. Behaviors were classified into three categories: full-screen, line-wise, and block-wise. Full-screen viewing was when users read each page and scrolls to change the entire screen with new text. Line-wise is when a users focuses on sections of the screen which they each line scrolling filling an area with new text. Block-wise is when users scroll to replace text in part of a screen. The commonality between all reading styles regardless of the format layout is that each required at least some level of scrolling within the text and users can modify their reading styles to accommodate to reduce scrolling requiring (2012).

During the study it was observed that most participants flipped the device on its side to maximize the length of the screen to reduce scrolling. Though the exact reading styles could not be concluded in this study, the finding of flipping the device supports the contention that users try to reduce scrolling. Research by Dundar and Akcayir also suggested that flipping a device constitutes a method to increase readability (2014). This suggests that users who needed to adjust their reading style to the smaller form constitutes a factor that may have impacted their preference on each task but not drastically enough to create a statistical difference. The need to collect more data focusing on in depth qualitative feedback is discussed in the future research section. Additional research will follow up to determine whether all statistically significant data displaying a higher preference for tablets does have an impact or not.

5.2 Writing Task Results

Within the writing task there was no statistical difference found for any of the questions. For the questions with no statistical difference the results were spread evenly by the device, indicating that there is no real difference in user preference in writing on tablets or smartphones. However, it was observed that users often held smartphones off the table while completing the task though the majority of participants kept the tablet on the table.

Further research has been conducted in this area, specifically around hand positions and mobile user interactions with devices. Previous studies have found that mobile device users are more likely to SMS with one-hand than with two-hands on devices (Kim et al., 2006). This may correlate to the rational that participants were more likely to lift the smartphone to complete the writing task, similar to how one sends an SMS. Smith has shown that SMS is more commonly completed on smartphones than tablets (2011), which supports the evidence that users were more likely to lift the smartphone compared to the tablet to complete the writing task.

As the methodology was taken from a study that focused on PC versus tablet usability, if the study is repeated, the research should include tasks involving writing with the device in your hand standing versus sitting at a table. That would provide additional information regarding the portability of a task while in use completing tasks, measuring how easy it is to type on the device while not in a stationary position. As smartphones were shown to have increased portability it can be assumed that the portability while completing a function such as writing would be increased on a smartphone but future research would need to be completed in this area to prove it.

5.3 Direct Manipulation Results

Within the direct manipulation task, screen responsiveness was found to have a statistical difference with smartphones ranking in preference. As the devices have the same technical ability to respond to touch, the results can be referred to user pre-disposition or experience within the task. As the surface area of the tablet has increased, it may limit the perceived operational ability. Recent studies have found that as touch-enabled screens has increased, the screen size has also increased, as it was perceived to constitute a better user experience but it has proven to actually decrease operational performance (Tsukamoto, Higuchi and Okado, 2014). The study utilizes heating mapping to track users usage based off the way they are holding a mobile device. In particular the study looks at when users are holding mobile devices with one hand what their range of movement is. The study argues that the top spots of usage directly correlate around hand placement. Therefore, on a larger screen the core area of access is much smaller than a small device (2014). As the study focused on using mobile devices with only a single hand, the results may be biased toward the smaller device, as there is only a single point of usage but many of the results do directly correlate to this study as users may have found issues reaching to different areas of the screen more challenging on the tablets therefore accounting for the statistical difference in smartphones having increased touch responsiveness.

As with the writing task, if the study is repeated, it should ask users to complete the task while standing and while sitting to verify if there is any difference in their responses. Hand positioning should be examined to identify how users are holding devices and if they are suitable to be used standing and moving. If the hot spots of user's ability to access the screen are focused around finger positioning than tablets may have a disadvantage in this area (Tsukamoto, Higuchi and Okado, 2014).

5.4 Camera Results

The camera task had the highest about of questions that had a statistical difference in terms of preference and performance. This includes ease of task, perceived quality of image, perceived low number of errors, and speed of task. As discussed the perceived quality will not be further discussed as the devices used within the test provided an unequal platform so results do not provide an accurate measure. It has been found that of smartphone users aged 18-19; 93% use the device to take photos and 81% of smartphone users to send picture and video messages (Anon, 2015). As smartphones provide SMS abilities that standard tablets do not offer users may have increased experience in using a smartphone to take pictures over a tablet as it provides the functionality to allow them to more easily send a picture. Furthermore, the size of the smartphone being smaller allows users to more easily reach the button to take the picture than a smartphone allows. Similar to the direct manipulation task, it has been found that areas closest to the user's hand positioning enables hot spots for access (Tsukamoto, Higuchi and Okado, 2014). On smartphones as the screen is smaller than that on tablets it enables them to more easily reach the capture button. It also has been found that using tablets for street photographers, or at large event not only can be invasive for the photographer but also is distracting for the people around them (Kelly, 2015). Utilizing a tablet in a busy setting has also been found to come off as aggressive and obtrusive in the fact that it may block others views (2015). Having a higher familiarity utilizing a device, the ability to more easily access the capture button, and the stigma of environmental factors all can impact the ease of use, likelihood to create errors and speed of completion. Research finding support the data collected within this research that smartphones have a higher preference and performance than tablets.

However, additional research has found that tablets may offer specific enhanced benefits in respect to picture taking over smartphones. Tablets provide a larger screen, which gives users a larger viewfinder (Kelly, 2015). Furthermore, tablets offer a better canvas to complete sophisticated photo editing as it provides users a larger image to work with (2015). Though the majority of data supports that smartphones provide the enhanced experience in respect to taking a picture, tablets do provide users with a few specific advantages that smartphones do not provide.

5.5 User Feedback Results

Within the final feedback users again confirmed that smartphones had a statistical preferences in their ability to be carried. Users ranked their preference in the reading task for the question ‘The device was portable’ and within the final user feedback the question ‘the device is ease to carry’ with the rating being higher for smartphones rather than tablets for each task. Smartphones ranked approximately (.5) higher in user preference over tablet for both questions. This suggested that overall users have a stronger preference for the mobility of smartphones as discussed within the reading task.

The comfort in completing all mobile computing on the device also displayed a statistical difference, with smartphones ranking as the device with the higher ability. Within each of the questions that had a statistical difference, smartphones enjoyed the higher preference. This correlates that the comfort to complete all mobile computing devices was ranked higher on smartphones.
The probability that smartphones meet all mobile computing needs was also proven to have a statistical difference, with smartphones ranking as the device with the higher functionality. Thus it can be assumed that standard voice calls are the main limitation of tablets. However, the probability that a smartphone could meet all needs was ranked higher than the comfort level to use a smartphone for all devices. Therefore, the research demonstrated that it is functionally possible but is not preferred by users. This supports the research that 41% use their tablet and smartphone simultaneously at least once a day (Marketing Cloud, 2014), confirming that both devices offer specific benefits to users. These conclusions are similar to the finding within the study by Ozok et al. which concluded that though tablets meet many user needs, there are still many aspects of computing that are better suited for PC’s (2008). The research also indicated that since tablets were fairly new to the market, it is too early to draw definitive conclusions. Since the study by Ozoko et al., tablets have appeared as complementary device rather than a replacement device (2008). This study draws similar conclusions.

5.6 Beneficiaries

Beneficiaries of the study were identified as: mobile device users, mobile app designers and developers, and device manufacturers. For mobile device users it can be concluded that if a user is looking to make their first purchase of a mobile computing device a smartphone is the best initial investment as it provides more well rounded comprehensive functionality than tablets. However, if a user has a smartphone and is utilizing the device for the main functionality of reading then a tablet may provide the user with additional benefits as a complimentary device.

Furthermore, mobile app designers and developers can conclude that if a new app were being created, the original app would be best optimized for smartphones as they provide users with a fuller range of functionality. Depending on the functionality of the app, a version for tablets should then be explored. If the key focal point of the app is reading information, a tablet version may be beneficial to users.

For manufacturers of mobile devices, the results are fairly inclusive. Smartphones were proven to have a more diverse set of functionality for users but further research in this area is needed before it can provide a real benefit for mobile device manufacturers. Smartphones proved to offer the stronger functionality set but in some respects tablets provided stronger user experience.

5.7 Study Limitations

Users in the study were selected via convenience sampling. This may have created potential for a biased users group as users came from a similar demographic (Oates, 2006). In order to account for this, the sample group was selected as a representation of the model demographic. This was addressed within the participation section of the research, which identifies how the sample size represents the population. However, there still may be limitations in the results due to convenience sampling used.

The results of the research were in many cases skewed higher than normalized data. As significant level are based on normalized data this may have an impact on the results of the research. Though research has proven that ANONA tests are robust enough to handle data that is not normalized it still may impact the research findings. As participants knew the researcher this may account for higher scores which has skewed the data set to be higher that a full normalized data set.

In addition, the study looked into users behaviors while performing specific tasks during a short period on time. The study did not explore any aspects of how users use mobile devices over a long period within their typical life. Each of the tasks was set out to perform in fairly quick manner therefore, if there is a difference in preference due to performing a task for a period of time this is not included in the research.

The study selected iPhone and iPads as the devices to keep a variable of control on what device were being used. Users were selected as being users of both devices. Moreover, it also limited variants of an unfamiliar operating system. In doing so, the study failed to include results from users of other mobile operating systems. Android is the most widely used, followed by iOS, then Windows (Adobe, 2014). The future research section addresses the methodology for future research to expand the current work to include additional operating systems to create a more robust data set.

During the reading task, the portability question displayed a limitation because the distance participants walked in the study varied slightly in distance. Therefore, this may have an impact on the results. Participants walked the same distance with each device, but the distance walked by participants may have varied as the size of the room where the study was conducted varied. In Ozok et al., the study took place in the same location. Therefore, this was not a variable for their research (2008). This study took precautions to ensure participants walked the same distance with each device but there still were slight variations among users.

5.8 Future Research

The study showed that there was a statistical difference for several tasks and that smartphones enjoy greater user preference. However, in the reading task, all questions that did not have a statistical difference ranked tablets with the higher user preference. As ANOVA tests take into account randomization of feedback if there was a split of tasks between tablets and smartphone preference for the questions that did not have a statistical difference, the results would prove inconclusive. As the research concluded that all questions without a statistical significant preferred tablets, further research in these areas is needed. A qualitative study should be completed to collect more in-depth information on user feedback. In order to collect more data, a future study should be conducted for the reading task that will have participants repeat the same tasks again but replacing the questionnaires with more in-depth user feedback while they complete the tasks.

As there was an error within the study that the devices used did not have the same screen resolution, the test of perceived quality should be repeated in a follow up study. To repeat the results for this task, devices with exactly the same resolution should be used. The direct manipulation task should then be repeated in its entirety, including the full questionnaires for each device following the task. Following the study, the two results sets for the full direct manipulation data set should be compared to determine if there is a statistical difference between the original results and the new results. If there is no statistical difference in the two data sets, excluding the question about resolution, it can be assumed that if the original participant group were given devices with the same resolution they would have answered the question the same way as the new group. However, if there is a statistical difference in the results by the new participant group versus the original, then the results should not be used as it can be assumed that the original participants would not have answered with the same responses. If there is a statistical difference then the full study should be repeated again except with the new devices, as it can be assumed that the full results set need to be repeated to gain accurate insight into the perception on screen resolution with respect overall feedback to the study.

Additional research should be conducted in this field that examines Android and Windows devices. Since the research is only completed on iOS devices, additional research on devices with different operating systems would strengthen the study. By adding additional devices, a more robust data set can be examined and analyzed. A follow up study should use devices that are similar in size to the iPad and iPhone used in this study and the participants that will be chosen should follow a similar participant group. The study should then be repeated in its entirety with the two new devices. Once the results are completed, they can be compared against the original data set to determine if there are any statistical differences in the data sets.

Along with this further research can be looked on different size devices within the category range. Within the study iPad and iPhone devices are used for the analysis but additional devices that can be categorized as mid-sized crossover devices could be used ex. iPad Mini or iPhone 6 Plus. The study should follow the same methodology as set out above for devices on each OS that has been completed. The results should be added as an extension to the data sets found within their operating system category to determine if there are statistical difference in the results by different size devices. The data set should then be taken and compared to that of devices that are running different operating systems to determine if there is a statistical difference in the mid sized mobile device category between different operating systems.

6.0 Conclusion

The following objectives were set forth to be the key drivers of the research: 1.) To determine users' attitudes towards smartphones 2.) To understand how smartphones are perceived as a mobile computing medium 3.) To consider the potential for smartphones to replace tablets, as the mobile computing platform. Utilizing the research conducted within the study, as well as the supporting information from the context section of the study, it can be concluded that users' attitudes towards smartphones as mobile computing devices has been shown to have a positive reception. The research determined that smartphones have key functionality that the tablets to do not offer, the main driver for this being basic phone functionality. This is supported by the research of Cui and Roto that voice communication is a main driver of mobile devices (2008). Although there are apps such as Skype and Viber that can be used on either device, standard call functionality requires Internet connectivity (VOIP) and does not allow users to contact all standard telephone numbers. The research supports the initial hypothesis to an extent in the fact that smartphones did outperform tablets in many areas however, unlike the hypothesis tablets have proven to still prove functionality benefits to users and therefore have a place in the market.

The research will now enable the beneficiaries to have a stronger understanding of functionality drivers for each of the mobile computing devices. The largest benefit that the research will provides is for new mobile app developers. As the research specifies which functionality is best suited for each device backed up by specific research within the study as well as with reference to additional studies. By providing a deeper understanding of mobile device functionality this allows mobile designers, and developers to create apps that are better suited for users. Enabling the rate of downloads to increase and the user experience to be increased for the applications.

Based on the knowledge gained from the study, if the study were to be repeated, the tasks should be focused more specifically on mobile devices. As all of the tasks except for one were modeled after a study around PC versus tablet usability, the full extent of using devices while mobile was not addressed sufficiently. The tasks should have included aspects such as standing or walking while completing tasks then collect user preference. This would have allowed for better insight into what device has the higher user preference when the device is being used as a mobile device to full capacity.

This comparative study sought to answer the research question: What are users' attitudes toward smartphones and how are they perceived within the mobile computing marketplace to determine if smartphones meet all mobile computing needs- in terms of being able to replace tablets. The research demonstrated that smartphones were very well received and that users have a very positive attitude towards them. Smartphones were proven to be perceived as the mobile device that have enhanced functionality over tablets. Lastly, it was proven that it is probable that smartphones meet all mobile computing needs of users. The research demonstrated that smartphones outperformed tablets in many areas in terms of user preference and usability however, tablets were deemed to possess qualities that provided benefits to users as well. Therefore, the study has concluded that at the current time, both smartphones and tablets have earned a place in the mobile computing market.

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Appendices:

Appendix A: Project Proposal

1.0 Introduction

Digital technology has given companies the power to reach users internationally expanding business globally making it possible to reach more users than in previous generations. When expanding globally companies modify many aspects of their business to localize. Localization is the process of modifying products or services, marketing techniques or business process to adapt particular culture. Many companies localize their web layouts; varying their site layout depending on the domain. Though localization is an important aspect for many business processes; within the digital age users are able to view websites from any countries creating users that have been exposed to global web layouts (Eristi, 2009). Has this occurrence broken down the need for localization of web layouts? Are there other influences that have a stronger impact on web layouts than country of origin? This study seeking to answer the question: in the digital age does a users country of origin or their personality have a stronger impact on their preference in web layouts.

The aim of the research is to seek to gain a better understands of web users preference in web layouts based on their country of origin and their personality. The research seeks to answer the question: Is country of origin or personality the more significant factor affecting preference in web layouts.

The objectives of the research are to:

1.) Gather information from participants about their preference in web layouts

2.) Analyze the impact country of origin and personality type has on participants preference in web layout preference

3.) Create sample web layouts utilizing the preferences found in the data set that has the stronger impact on web preference

The initial hypothesis is that personality type will have a stronger influence on preference of web layouts than culture. The world has become smaller with the emersion of digitalization and therefore it is projected that an individual's culture will have less of an impact on their design preference (Reinecke and Gajos, 2014) and Given this is true, within the research sample designs of the best web layouts will be created for each personality type in the study.

This research study hopes to provide individuals and companies that are creating or re-design their webpage a deeper understanding of their users. Currently determining how users perceive web layouts on a site is a huge part of business but unfortunately much of this information is proprietary to the company completing the research. This limits newer companies emerging into the digital marketplace to have access to such information. Though a single layout will not meet the preferences of every user by having a layout that appears to the majority of their target market provides an distinct advantage for businesses to draw in more customers.

2.0 Critical Context

The thesis covers a hybrid of international studies and psychology; and the impact each has on web layouts preferences. Within the research many previous studies and their findings have been referenced to provide a knowledge base and supporting data.

The first aspect of the research looks into how a person's culture impacts their preference on web layouts. One of the most referenced principles within similar studies is Hofstede's five dimensions culture. It has been used in such studies as Robin's and Stylianou's work 'Global corporate web sites' (2001) as well as Soares, Fangmeher and Shoham's study 'Hofstede's dimension of culture in international marketing studies' (2007). Within Hofstede's work he classifies cultures into six cultural clusters based on cultural similarities and location these are: Anglo cluster, Nordic Cluster, German Cluster, Latin Cluster, Asian Cluster and Japan Cluster (Robbins, S. S. and Stylianou, A. C. 2001). This research will use Hofstede's grouping but will only use the: Anglo, German, Latin and Asia cultural clusters within this report. The remaining groups can be looked into for future research. By not utilizing all cultural clusters a limitation is put on the research but, it offers cleaner results set then if cultural clusters are merged within this study.

The second aspect of the research looks into psychology of human personality. Within the research the main aspects of personality that will be referenced will be pulled from Myers Brinks personality traits. Myers Brinks is an established study that has been used in similar studies including Huang and Yang's research 'The impacts of homepage screen design on website density on website evaluations: the moderating role of personality type' (2011) and Orchard and Fullwood's 'Current perspectives on personality and Internet use' (2010). The standard Myers Briggs classification has 16 different personality classifications (Cohen, Ornoy and Keren, 2013). This study uses an abbreviated version of the Myers Briggs test will be used for time sake of the participants that breaks down the categories into four primary Myers Briggs personality types: dominant intuitive, dominant sensing, dominant thinking, and Dominant Feeling (Cohen, Ornoy and Keren, 2013).

The third aspect of the research looks into the elements of web design. The elements of web layouts that will be used within this study will be pulled from Shelly and Campbell's 'Web design' (2012). The elements within the book that will be used have also been reference within either within 'Profession Web Design' (Eccher, 2011) or 'The principles of beautiful web design' (Beaird, Farley and Simoneau, 2010) to provide validity to the elements referenced. The elements of web design that will be looked at will be: top vs left navigation, high white space vs low white space, symmetric vs asymmetric balance, high vs low content, proximity vs distance, repetition vs distinct designs, large vs small navigation options and large vs small logo (Eccher, 2011). Similar studies have concluded that sites within the Asian cultural group low amounts of white space while sites within the Nordic cultural cluster have more space (Marcus, Aaron and Gould, Emilie West, 2000). Furthermore, the study 'How visualization layout relates to Locus of Control and Other Personality Factors' has found that people who score high on the judgement scale of the Myers Briggs personality type prefer more white space and cleaner

navigation than those who scored lower within the judgement scale (Ziemkiewicz et al., 2013). Utilizing past studies it has been proven that country of origin and personality have an effect on web layouts and this study aims to determine which of these has the stronger impact.

3.0 Methodology

Within this study information from users will be collected to gather information. Experiment participants will be asked to complete the study via Amazon Mechanical Turk. Amazon Mechanical Turk is a online results generator that has participants log in and complete tasks for a set pay. It been used in several studies such as Heer and Bostock's 'Crowdsourcing Graphical Perception: Using Mechanical Turk to Assess Visualization Design' (2010). Within Amazon Mechanical Turk the project will be set up as a survey (Mturk.com, 2014). Users are then able to log in and complete the questions by inputting an answer or selecting a multiple choice option. The hit will be set up so users can only participate once to reducing the chance that a user participate multiple times which could skew results (mturk.com,2014). Utilizing Amazon Mechanical Turk has the limitation that most users will be more advanced web users creating limited information to be found from novice web users losing out on information from that user group. Along with this Amazon Mechanical Turk has the limitation that some test takers will take the test without fully reading the instructions in order to earn the pay quicker. In order to account for this questions will be placed into the survey to verify that users are completing the survey accurately.

Participants within Amazon Mechanical Turk will be asked to complete the following:

1.) Task One: Participants will be asked to read the participants information sheet as documented within the appendix of this document. They will then select Agree or disagree. If they agree they continue if not then the task will be stopped at that point.

2.) Task Two: Users will be asked to input their country of origin

3.) Task Three: Users will complete an abbreviated Myers Briggs personality test the questions from this test will be pulled from an existing source. (Personalitypathways.com, 2014).

4.) Task Four: Users will be given 10 questions. Within each question two screen layouts will display the user will be asked to select their preference in the web layout or select the layout are the same if the layouts are the same.

Users will not receive any information back from the study they simply input the information that will them be used for the analysis. As the data is being collected the organization of the data will begin.

Two of the ten web layout questions will display the same web layout, these act as the control to make sure that the user is fully reading the question. If they do not answer these two questions are correctly the hit will not be used in this study.

The country of origin will be grouped into Anglo cluster- Australia, Canada, UK, Ireland, New Zealand, South Africa and US, Nordic Cluster- Denmark, Finland, Netherlands, Norway and Sweden, German Cluster- Germany, Austria, Isreal and Switzerland, Latin Cluster- Belgium, Brazil, France, Italy, Mexico, South American countries and Spain, Asian Cluster- China, Hong Kong, India, Malaysia, Phillippines and Sigapore, and Japan Cluster- Japan (Robbins, S. S. and Stylianou, A. C. 2001). If the user inputs a country that is not listed above then the answers will not be used within this study but will be saved for future research.

The answers from the Myers-Briggs questioner will also used to determine the personality type of each participant. The groups will be categorized into the primary four Myers Brigg's categories: dominant intuitive (INFJ, INTJ, ENFP, ENTP), dominant sensing (ISFJ, ISTJ, ESFP, ESTP), dominant thinking (ISTP, INTP, ESTJ, ENTJ) and dominant feeling (ISFP, INFP, ESFJ, ENFJ) (Cohen, Ornoy and Keren, 2013).

Within an excel document the country of origin, personality type and layout preference per figure will be for each participant. Once the data is collected to contain a minimum of 30 responses from each cultural cluster and a minimum of 30 for each personality type the results will be categorized.The information will then be used with Spear's rank correlation coefficient to determine the impact country of origin and personality has on layout preference (Oates).

One table will be used to display figure selected vs country of origin. This table will set to seek determine the objective:

H0: Country of origin does not have an impact on figure selected
H1: Country of origin does have an impact on figure selected.

The second table will display ranking vs country of origin by personality type. This table will set to seek determine the objective:

H0: Personality does not have an impact on figure selected
H1: Personality does have an impact on figure selected.

From this data a chi-sqaured test will created to determine if there is a impact in either of data sets and if so which has the stronger impact.

If there is a impact found within either data set then example layouts will be created. If both data sets have a impact the data set with the stronger impact will be used, to model ideal web layouts by category. Furthermore, if country of origin has the stronger impact then model web design layouts will be created to display the ideal web formats for the Anglo cluster, Nordic Cluster, German Cluster, Latin Cluster, Asian Cluster and Japan Cluster to capture the results identified. If personality is found to have the stronger impact then ideal web design layouts will be created for dominant intuitive, dominant sensing, dominant thinking and dominant feeling personality types.

Factors such as culture or the country that the person currently resides in will not be looked at for this study. Family factors such as if the person is a first generation within their family to have lived within that country will not be looked into. Personality qualification will also be limited to the Myers Briggs classification. There is a variety of different personality clarifications on the market but as Myers Briggs is the most commonly used personality classification used within similar studies this has been chosen for this study. The web layouts that will be looked into will only be the eight variations as identified above. Similar studies have looked at other elements such as color, content, types of graphics and types of images (Ziemkiewicz et al., 2013), these will be not be included within this study but can be addressed within future research.

The hit in Amazon Mechanical Turk will only display in English this means participants will have to have to a basic level of English skills to be able to participate in the survey. This limits the sample of participants that can be in the study.

This study will only be looking at web page layouts from a standard desktop view, it will not include phone or tablet technologies. Though aspects of the results can be applied to mobile technologies actual layouts for these platforms will not be used within this study.

4.0 Scope of Work

The scope of work below displays the plan of work to capture the timeline of the project. The project start date will be begin June 1st and the end date is the Sept 27th. The dates are planned out to work 5 days a week so if time delays occur work can be completed on weekends to make up for lost time. Also the planned deadline is set for before the project is due to create an additional buffer if needed.

Phase 1: is to create the web layout wireframes for the survey based off the elements proposed. Task 2 cannot be completed until this task is complete.
Phase 2: is to create the Amazon Mechanical Turk hit. This is set to be complete is one day as the account is already set and just requires that the screen layouts to be input. Phase 3 cannot be started till task 2 is complete.
Phase 3: will run independently and collect the data as needed for the study. This will occur in parellel with Phase 4.
Phase 4: is to organize the data collected within phase 3 and will begin as soon as results from Phase 3 are returned. Phase 5 cannot be completed until Phase 4 is complete.
Phase 5: is to create the chi-squared test and will begin as soon as all results from phase 3 and 4 have been obtained and organized. Phase 4 will be done in parelel with phase 5.
Phase 6: is to run the chi-squared test and analyze the data and will be done with phase 5 to determine the results of the surveys. Phase 6 will begin once phase 5 is complete.
Phase 7: is to find additional supporting material. This is an optional phase that will used as needed to find additional resource to support finding to support the research of the model layouts as well as the final report. Phase 6 will be done in parrell with phase 7 and 8.
Phase 8: is to create the model layouts from the information collected. will begin as soon as phase 5 is complete. Phase 8 cannot start until phase 7 is complete.
Phase 9: is to start the rough draft of the repot and will begin once phase 8 is complete. Phase 10 cannot start till phase 9 is complete.
Phase 10: is to edit the report and will begin once phase 9 is completed. Phase 11 will not start till 10 is complete. This will include improving content and adding additional information from previous studies to support the finding. Following adding in the additional information the report will be edited for spelling and grammar. The end version of the report should be finalized to a high standard and could potentially be submitted.
Phase 11: is the final report is complete and will be met once phase 10 is complete.This phase is set to perfect all aspects of the study. This includes formatting and additional spelling and grammar changes.

	Jun 1-15	Jun 16	Jun 16-27	Jun 30-July 11	July 11	July 11-25	July 28-Aug 22	Aug 25-Sept 19	Sept 19-26
Phase 1: Create web layouts	X								
Phase 2: Create Amazon Mechanical Turk Hit		X							
Phase 3: Collect Results			X						
Phase 4: Organize Data			X						
Phase 5: Create Chi-Squares Test				X					
Phase 6: Create Correlation Metrics				X					
Phase 7: Further research studies to support findings					X	X	X		
Phase 8: Create model layouts						X			
Phase 9: Rough Draft							X		
Phase 10: Edit Draft								X	
Phase 11: Final Draft									X

5.0 Risk Register

Risk Register				
Risk	Probability	Impact	Risk Mitigation Action	Contingency Plan
1.) Limited data on subject	M	H	-Creating own data through for analysis. -More detailed research on topic.	-Using older articles if needed.
2.) Project Deletion	L	H	-Save frequently. -Save on multiple platforms remote cloud storage platforms.	-Use an older copy that was saved earlier.
3.) Not finding common elements in sites from the same cultures	L	M	-Narrowing cultural regions to identify similar topics.	-Citing previous research to gain insight on cultural areas and elements to look for.
4.) Not having enough users to test the elements that I add to my site.	M	M	-Using Amazon Terk to increase the number of users.	-Increase users pay as needed.
5.) Amazon Terk services no longer is available.	L	H	-Using social media to reach out to people to increase number of users.	-Paying users through other outlets to complete the survey.
6.) Timelines running over. Not meeting set dates.	M	H	-The completion date in the work plan is set as a month earlier than due to allow for error.	-Work on weekends will be used as needed to catch up.
7.) Not having the heat mapping, eye tracking software needed to track users responses	L	H	-Using the eye tracking software that City University instead.	-Rely on the survey responses that users provide.
8.) Moving from London- need to complete the project remotely	M	L	-Using tools such as Skype or Google Hangouts to communicate with advisor -Post the finalized printed copy.	-Fly back to London for a mandatory discussion or to turn in the final presentation.

6.0 Ethical, Professional & Legal Issues

6.1 Adequate Pay

Since users will be elicited within this study it will be ensured that users will be paid at least minimum wage for their work. The expected time that the test will take is 8 minutes. In order to account for different users the average time will be set for 10 minutes. The current federal minimum wage in the US is $7.25 per hour (U.S. Department of Labor - Find It By Topic - Wages - Minimum Wage, 2014). Using these figures as a base calculate the total pay per hit needs to be a minimum of $1.20. Due to variance of minimum wage by state as well as country the payment will be set at $2.00 per hit to reduce chances of any ethical issues of paying users an unfair wage.

6.2 Citing Previous Research

The report will make reference to multiple previous works of literature that will be used as base knowledge and to support information. In doing this in order to avoid any professional or legal issues any information that will be used will be referenced in accordance Harvard Citing style to reflect the original body of work.

6.5 Users of protected classes

Users of protected classes not have any impact on the study- therefore if a users of a protected class chooses to do the study they may but they are required to do so. No special data will be tracked for any users and all users data will be treated equally and tracked unanimously.

Along with this within Amazon Mechanical Terk the setting will block any user under the age of 18 to take the study. This eliminates the changes that a minor may participate in the study.

6.6 Users consent

All users will receive an information sheet about the research prior to the study- see section 9.0. The sheet will contain all necessary information about the study for the users. There will also be a consent form that users must initial prior to beginning. As the study will be completed virtually a signature cannot be captured- along with this by simply receiving the initials of the user the user can remain unanimous in the study.

7.0 Bibliography

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In-text: (Eristi, 2009)

8.0 Ethics Documents

Ethics Checklist

Research Ethics Checklist
School of Informatics BSc, MSc, MA Projects

If the answer to any of the following questions (1 – 3) is NO, your project needs to be modified.		*Delete as appropriate*
1.	Does your project pose only minimal and predictable risk to you (the student)?	**Yes**
2.	Does your project pose only minimal and predictable risk to other people affected by or participating in the project?	**Yes**
3.	Is your project supervised by a member of academic staff of the School of Informatics or another individual approved by the module leaders?	**Yes**
If the answer to either of the following questions (4 – 5) is YES, you MUST apply to the University Research Ethics Committee for approval. (You should seek advice about this from your project supervisor at an early stage.)		*Delete as appropriate*
4.	Does your project involve animals?	**No**
5.	Does your project involve pregnant women or women in labour?	**No**
If the answer to the following question (6) is YES, you MUST complete the remainder of this form (7 – 19). If the answer is NO, you are finished.		*Delete as appropriate*
6.	Does your project involve human participants? For example, as interviewees, respondents to a questionnaire or participants in evaluation or testing?	**Yes**
If the answer to any of the following questions (7 – 13) is YES, you MUST apply to the Informatics Research Ethics Panel for approval and your application may be referred to the University Research Ethics Committee. (You should seek advice about this from your project supervisor at an early stage.)		*Delete as appropriate*
7.	Could your project uncover illegal activities?	**No**
8.	Could your project cause stress or anxiety in the participants?	**No**
9.	Will you be asking questions of a sensitive nature?	**No**
10.	Does your project rely on covert observation of the participants?	**No**
11.	Does your project involve participants who are under the age of 18?	**No**
12.	Does your project involve adults who are vulnerable because of their social, psychological or medical circumstances (vulnerable adults)?	**No**
13.	Does your project involve participants who have learning difficulties?	**No**
The following questions (14 – 16) must be answered YES, i.e. you MUST COMMIT to satisfy these conditions and have an appropriate plan to ensure they are satisfied.		*Delete as appropriate*
14.	Will you ensure that participants taking part in your project are fully informed about the purpose of the research?	**Yes**
15.	Will you ensure that participants taking part in your project are fully informed about the procedures affecting them or affecting any information collected about them, including information about how the data will be used, to whom it will be disclosed, and how long it will be kept?	**Yes**
16.	When people agree to participate in your project, will it be made clear to them that they may withdraw (i.e. not participate) at any time without any penalty?	**Yes**
The following questions (17 – 19) must be answered and the requested information provided.		*Delete as appropriate*
17.	Will consent be obtained from the participants in your project? Consent from participants will be necessary if you plan to gather personal, medical or other sensitive data about them. "Personal data" means data relating to an identifiable living person; e.g. data you collect using questionnaires, observations, interviews, computer logs. The person might be identifiable if you record their name, username, student id, DNA, fingerprint, etc. *If **YES**, provide the consent request form that you will use and indicate who will obtain the consent, how are you intending to arrange for a copy of the signed consent form for the participants, when will they receive it and how long the participants will have between receiving information about the study and giving consent, and when the filled consent request forms will be available for inspection (**NOTE**: subsequent failure to provide the filled consent request forms will automatically result in withdrawal of any earlier ethical approval of your project):*	**Yes**
18.	Have you made arrangements to ensure that material and/or private information obtained from or about the participating individuals will remain confidential? *Provide details:Since all data will be collected unanimously I will have no information on the individual user therefore the user is protected.*	**Yes**
19.	Will the research be conducted in the participant's home or other non-University location? *If **YES**, provide details of how your safety will be preserved: The user will be completing the information online via their personal device and therefore may complete the research anywhere they feel safe and comfortable that has an internet connection.*	**Yes**

PARTICIPANT INFORMATION SHEET
City University of London
Web Layout Preference

We would like to invite you to take part in a research study. Before you decide whether you would like to take part it is important that you understand why the research is being done and what it would involve for you. Please take time to read the following information carefully to decide it you would like to participate.

What is the purpose of the study?
The purpose of the study is to better understand preferences in web layouts.
Why have I been invited?
You have been invited as you are a web user.
Do I have to take part?
Participation in the project is voluntary, and you can choose not to participate in part or all of the project. You can withdraw at any stage of the project without being penalised or disadvantaged in any way. It is up to you to decide whether or not to take part. If you decide to take part you are still free to withdraw at any time and without giving a reason.
What will happen if I take part?
You will input your country of origin
You will be asked 4 questions about yourself- you will select an answer out of 2 multiple choice options
You will be asked 8 questions about your preferred web layout- you will select an answer out of 2 multiple choice options
Expenses and Payments (if applicable)
You will be paid a flat rate of $2.00 for participating.
What do I have to do?
Input your country of origin and then answer a total of 12 questions.
What are the possible disadvantages and risks of taking part?
The study will take place at the comfort of where ever you choice. Therefore the risks associates would only be the risks associated with being in the area you select while taking part.
What are the possible benefits of taking part?
Paid compensation
Assist in increasing knowledge base of preference in web layouts
What will happen when the research study stops?
The user will have no impact when the study stops.
Will my taking part in the study be kept confidential?
Yes. The study is double blind and the researcher will never have any personal information about you.
What will happen to results of the research study?
The results of the research study have the possibility to be published in academic papers. As the study is double blind the participant will receive no information about the results.

Thank you for taking the time to read this information sheet.

Participant Consent Form
City University of London
Web Layout Preferences

1.	I agree to take part in the above City University London research project. I have had the project explained to me, and I have read the participant information sheet, which I may keep for my records. I understand this will involve: • using a computer to view webpages and provide feedback	
2.	This information will be held and processed for the following purpose(s): I understand that any information I provide is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party. No identifiable personal data will be collected.	
3.	I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalized or disadvantaged in any way.	
4.	I agree to City University London recording and processing this information about me. I understand that this information will be used only for the purpose(s) set out in this statement and my consent is conditional on the University complying with its duties and obligations under the Data Protection Act 1998.	
5.	If agreed select the I agree radio option below to continue and participate in the study.	

Appendix B: Ethics Checklist

Research Ethics Checklist

School of Informatics BSc, MSc, MA Projects

If the answer to any of the following questions (1 – 3) is NO, your project needs to be modified.		*Delete as appropriate*
1.	Does your project pose only minimal and predictable risk to you (the student)?	Yes
2.	Does your project pose only minimal and predictable risk to other people affected by or participating in the project?	Yes
3.	Is your project supervised by a member of academic staff of the School of Informatics or another individual approved by the module leaders?	Yes
If the answer to either of the following questions (4 – 5) is YES, you MUST apply to the University Research Ethics Committee for approval. (You should seek advice about this from your project supervisor at an early stage.)		*Delete as appropriate*
4.	Does your project involve animals?	No
5.	Does your project involve pregnant women or women in labour?	No
If the answer to the following question (6) is YES, you MUST complete the remainder of this form (7 – 19). If the answer is NO, you are finished.		*Delete as appropriate*
6.	Does your project involve human participants? For example, as interviewees, respondents to a questionnaire or participants in evaluation or testing?	Yes
If the answer to any of the following questions (7 – 13) is YES, you MUST apply to the Informatics Research Ethics Panel for approval and your application may be referred to the University Research Ethics Committee. (You should seek advice about this from your project supervisor at an early stage.)		*Delete as appropriate*
7.	Could your project uncover illegal activities?	No
8.	Could your project cause stress or anxiety in the participants?	No
9.	Will you be asking questions of a sensitive nature?	No
10.	Does your project rely on covert observation of the participants?	No
11.	Does your project involve participants who are under the age of 18?	No
12.	Does your project involve adults who are vulnerable because of their social, psychological or medical circumstances (vulnerable adults)?	No
13.	Does your project involve participants who have learning difficulties?	No
The following questions (14 – 16) must be answered YES, i.e. you MUST COMMIT to satisfy these conditions and have an appropriate plan to ensure they are satisfied.		*Delete as appropriate*
14.	Will you ensure that participants taking part in your project are fully informed about the purpose of the research?	Yes
15.	Will you ensure that participants taking part in your project are fully informed about the procedures affecting them or affecting any information collected about them, including information about how the data will be used, to whom it will be disclosed, and how long it will be kept?	Yes
16.	When people agree to participate in your project, will it be made clear to them that they may withdraw (i.e. not participate) at any time without any penalty?	Yes
The following questions (17 – 19) must be answered and the requested information provided.		*Delete as appropriate*
17.	Will consent be obtained from the participants in your project? Consent from participants will be necessary if you plan to gather personal, medical or other sensitive data about them. "Personal data" means data relating to an identifiable living person, e.g. data you collect using questionnaires, observations, interviews, computer logs. The person might be identifiable if you record their name, username, student id, DNA, fingerprint, etc. *If YES, provide the consent request form that you will use and indicate who will obtain the consent, how are you intending to arrange for a copy of the signed consent form for the participants, when will they receive it and how long the participants will have between receiving information about the study and giving consent, and when the filled consent request forms will be available for inspection (**NOTE**: subsequent failure to provide the filled consent request forms will automatically result in withdrawal of any earlier ethical approval of your project).*	Yes
18.	Have you made arrangements to ensure that material and/or private information obtained from or about the participating individuals will remain confidential? *Provide details: Since all data will be collected unanimously I will have no information on the individual user therefore the user is protected.*	Yes
19.	Will the research be conducted in the participant's home or other non-University location? *If YES, provide details of how your safety will be preserved: The user will be completing the information online via their personal device and therefore may complete the research anywhere they feel safe and comfortable that has an internet connection.*	Yes

Appendix C: Participant Information Form

PARTICIPANT INFORMATION SHEET
City University of London
Web Layout Preference

We would like to invite you to take part in a research study. Before you decide whether you would like to take part it is important that you understand why the research is being done and what it would involve. Please take time to read the following information carefully to decide if you would like to participate.

What is the purpose of the study?
The purpose of the study is to gain a better understanding of user preferences in mobile devices.
Why have I been invited?
You have been invited as you are a user of an iPhone and iPad.
Do I have to take part?
Participation in the project is voluntary, and you can choose not to participate in any part or all of the study. You can withdraw at any stage of the project without being penalized or disadvantaged in any way. It is up to you to decide whether or not to take part. If you decide to take part you are still free to withdraw at any time and without giving a reason.
What will happen if I take part?
You will be expected to go to the pre-assigned location. You will be asked to complete basic tasks on a iPhone and iPad. The full study will take about ½ hour.
Expenses and Payments (if applicable)
N/A
What do I have to do?
Within the study you report to the pre-decided location. Any questions you have will be reviewed- then you sign a consent form that you like to participate. You will then complete four tasks reading, writing, direct manipulating (completing gestures) and camera (take a picture) on an iPad and iPhone. Following each task on each device you will be asked to complete a questionnaire around your user preference on completing the task. Once the tasks are complete you are finished with the study and no follow up will be needed.
What are the possible disadvantages and risks of taking part?
The study will take place at the comfort of a location of your choice. Therefore the risks associates would only be the risks associated with being in the area you select while taking part.
What are the possible benefits of taking part?
Assist in increasing knowledge of mobile device usage.
What will happen when the research study stops?

Once the user completes the study they will no longer have any involvement in the research.

Will my taking part in the study be kept confidential?

Yes. No personal information will be stored about the participant but the videos will be included within the research.

What will happen to results of the research study?

The results of the research will be submitted to City University of London as part of a Masters Thesis. They will have no direct impact on yourself.

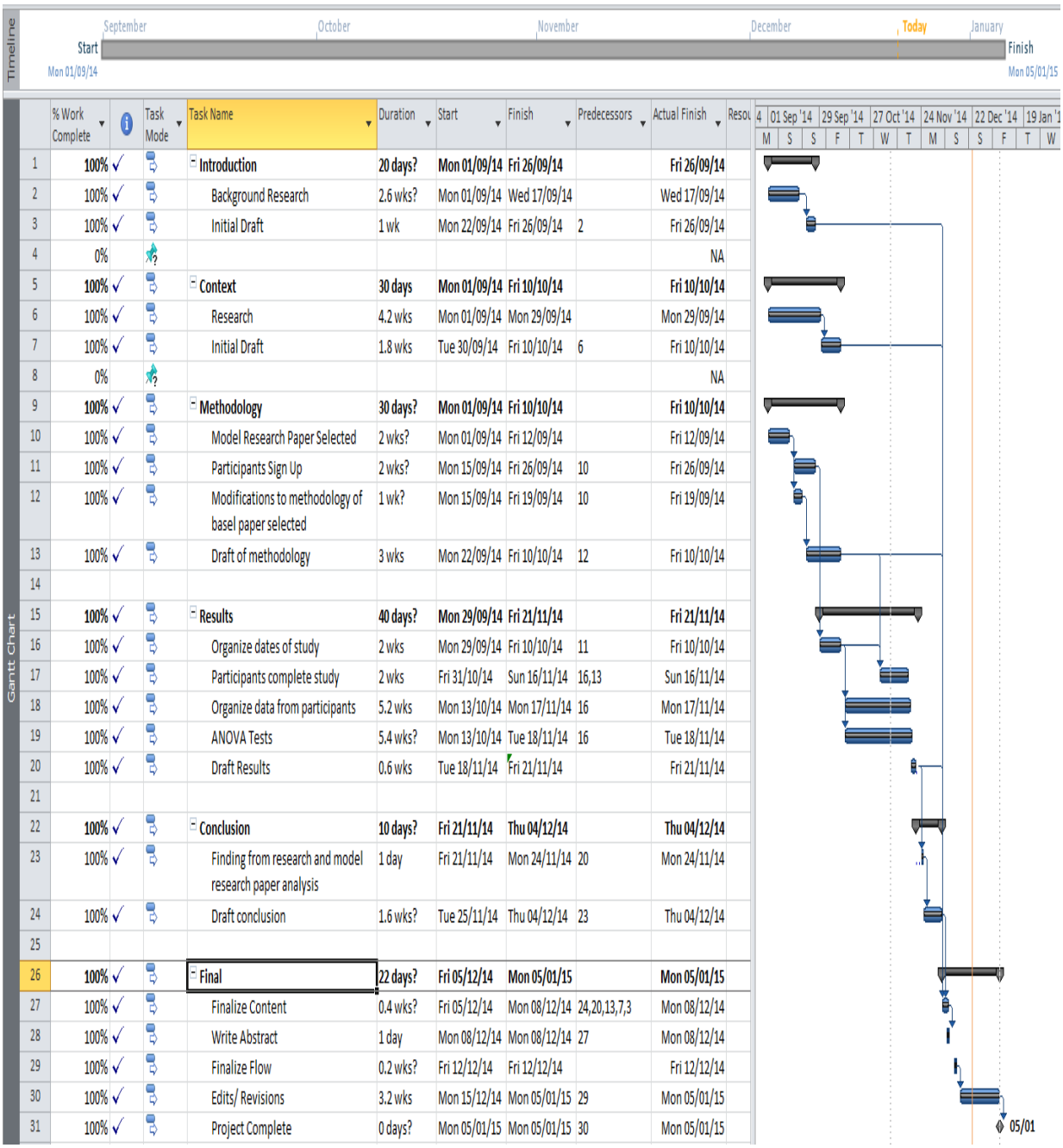
Thank you for taking the time to read this information sheet.

Appendix D: Participant Consent Form

Participant Consent Form
City University of London
Web Layout Preferences

1.	I agree to take part in the above City University London research project. I have had the project explained to me, and I have read the participant information sheet, which I may keep for my records. I understand this will involve: Completing tasks on a mobile devices: smartphones and tablets. Then completing questionnaires about my experience during the tasks. Participation will take approximately half hour with no follow up needed. Check the box to the right if understood.	
2.	This information will be held and processed for the following purpose(s): I understand that any information I provide is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party. No identifiable personal data will be collected. Check the box to the right if understood.	
3.	I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalized or disadvantaged in any way. Check the box to the right if understood.	
4.	I agree to City University London recording and processing this information about me. I understand that this information will be used only for the purpose(s) set out in this statement and my consent is conditional on the University complying with its duties and obligations under the Data Protection Act 1998. Check the box to the right if understood.	
5.	If agreed then initial the box to the right to confirm consent to participate in the study.	

Appendix E Project Plan



	% Work Complete	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Actual Finish
1	100%		**Introduction**	**20 days?**	**Mon 01/09/14**	**Fri 26/09/14**		**Fri 26/09/14**
2	100%		Background Research	2.6 wks?	Mon 01/09/14	Wed 17/09/14		Wed 17/09/14
3	100%		Initial Draft	1 wk	Mon 22/09/14	Fri 26/09/14	2	Fri 26/09/14
4	0%							NA
5	100%		**Context**	**30 days**	**Mon 01/09/14**	**Fri 10/10/14**		**Fri 10/10/14**
6	100%		Research	4.2 wks	Mon 01/09/14	Mon 29/09/14		Mon 29/09/14
7	100%		Initial Draft	1.8 wks	Tue 30/09/14	Fri 10/10/14	6	Fri 10/10/14
8	0%							NA
9	100%		**Methodology**	**30 days?**	**Mon 01/09/14**	**Fri 10/10/14**		**Fri 10/10/14**
10	100%		Model Research Paper Selected	2 wks?	Mon 01/09/14	Fri 12/09/14		Fri 12/09/14
11	100%		Participants Sign Up	2 wks?	Mon 15/09/14	Fri 26/09/14	10	Fri 26/09/14
12	100%		Modifications to methodology of basel paper selected	1 wk?	Mon 15/09/14	Fri 19/09/14	10	Fri 19/09/14
13	100%		Draft of methodology	3 wks	Mon 22/09/14	Fri 10/10/14	12	Fri 10/10/14
14								
15	100%		**Results**	**40 days?**	**Mon 29/09/14**	**Fri 21/11/14**		**Fri 21/11/14**
16	100%		Organize dates of study	2 wks	Mon 29/09/14	Fri 10/10/14	11	Fri 10/10/14
17	100%		Participants complete study	2 wks	Fri 31/10/14	Sun 16/11/14	16,13	Sun 16/11/14
18	100%		Organize data from participants	5.2 wks	Mon 13/10/14	Mon 17/11/14	16	Mon 17/11/14
19	100%		ANOVA Tests	5.4 wks?	Mon 13/10/14	Tue 18/11/14	16	Tue 18/11/14
20	100%		Draft Results	0.6 wks	Tue 18/11/14	Fri 21/11/14		Fri 21/11/14
21								
22	100%		**Conclusion**	**10 days?**	**Fri 21/11/14**	**Thu 04/12/14**		**Thu 04/12/14**
23	100%		Finding from research and model research paper analysis	1 day	Fri 21/11/14	Mon 24/11/14	20	Mon 24/11/14
24	100%		Draft conclusion	1.6 wks?	Tue 25/11/14	Thu 04/12/14	23	Thu 04/12/14
25								
26	100%		**Final**	**22 days?**	**Fri 05/12/14**	**Mon 05/01/15**		**Mon 05/01/15**
27	100%		Finalize Content	0.4 wks?	Fri 05/12/14	Mon 08/12/14	24,20,13,7,3	Mon 08/12/14
28	100%		Write Abstract	1 day	Mon 08/12/14	Mon 08/12/14	27	Mon 08/12/14
29	100%		Finalize Flow	0.2 wks?	Fri 12/12/14	Fri 12/12/14		Fri 12/12/14
30	100%		Edits/ Revisions	3.2 wks	Mon 15/12/14	Mon 05/01/15	29	Mon 05/01/15
31	100%		Project Complete	0 days?	Mon 05/01/15	Mon 05/01/15	30	Mon 05/01/15

Appendix F: Risk Register

Risk:	Probability	Impact	Risk Mitigation Action	Contingency Plan
Limited Data on Subject	Low	Medium	Pre-research has been completed to ensure there is data in this area.	Research additional topics around this area that would support the topic.
Project Deletion	Low	High	Save the file on multiple locations to ensure the file is backed up.	If the file is not backed then the last saved version will use.
Not having enough participants	Low	Medium	Ensuring that participants are arranged ahead of time.	Paying additional participants to complete the study.
Timelines running over. Not meeting dates.	Low	Medium	Ensure the timelines set are reasonable and are able to be accomplished on schedule.	Timelines are set for during the week only. If timelines are close then weekend work will be completed.
Moving from London- Complete the Project Remotely	Low	Low	Scheduling video conferences for meetings with supervisor.	Fly over to London if meetings in person are needed.

Appendix G: Reading Task Results

Reading Task: Tablet Results

	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9	1-10
p1:	4	5	5	5	4	5	5	5	5	62.3
p2:	5	4	5	5	5	5	4	5	5	64.1
p3:	4	5	4	5	5	4	5	5	4	61.3
p4:	4	4	5	5	5	5	3	2	5	60.4
p5	5	5	4	4	3	3	5	3	4	64.2
p6	4	5	5	5	5	5	5	5	5	60.8
p7	4	5	3	5	3	4	3	5	5	59.7
p8	3	4	5	4	5	2	5	4	5	65.9
p9	5	5	5	5	4	5	4	4	4	61.3
p10	4	5	4	5	5	5	5	5	5	61.9
p11	3	5	4	4	5	5	5	5	4	65.0
p12	4	3	4	5	4	4	4	5	5	67.1
p13	3	5	5	5	3	3	4	5	5	68.9
p14	3	4	4	4	4	4	5	4	5	70.1
p15	4	5	5	5	5	5	5	5	5	65.4
p16	4	4	4	4	5	5	4	4	5	61.9
p17	5	5	3	4	4	4	5	4	4	66.9
p18	5	5	5	4	5	5	5	5	5	63.2
p19	3	5	2	5	3	2	3	3	3	65.9
p20	5	5	5	4	5	4	5	5	4	70.3
p21	4	3	5	4	4	4	4	4	5	64.2
p22	4	4	4	4	5	5	5	5	4	66.3
p23	4	5	5	5	5	4	5	5	4	69.7
p24	4	5	4	5	5	5	4	4	4	58.8
p25	4	5	4	5	4	3	5	5	5	61.2

Reading Task: Smartphone Results

	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9	1-10
p1:	3	4	4	4	5	3	5	4	4	61.8
p2:	5	5	5	5	5	3	5	4	5	63.4
p3:	5	4	4	4	5	4	4	5	5	60.1
p4:	3	4	5	3	5	4	3	4	5	61.2
p5	5	5	4	5	4	3	5	3	4	63.4
p6	4	5	4	4	5	5	5	4	5	62.1
p7	5	5	3	5	5	3	3	5	5	58.7
p8	3	4	5	4	5	2	4	4	5	67.8
p9	5	5	4	4	5	5	4	4	4	60.5
p10	5	5	4	5	5	5	5	3	5	60.7
p11	4	5	4	4	5	5	4	5	4	66.7
p12	4	3	4	4	5	4	4	5	5	68.2
p13	3	5	5	4	5	3	4	5	5	71.1
p14	5	4	2	4	5	4	4	4	5	69.3
p15	5	5	5	5	5	5	5	4	4	63.2
p16	4	4	4	4	5	5	5	4	5	61.2
p17	5	5	3	5	5	4	5	4	4	67.9
p18	5	4	4	4	5	5	5	5	5	64.6
p19	2	5	1	2	5	1	3	4	2	66.2
p20	4	5	5	4	5	4	5	5	4	69.3
p21	4	3	5	3	4	5	3	4	4	64.2
p22	5	4	4	4	5	5	4	5	4	66.3
p23	4	5	5	5	5	4	3	4	4	69.5
p24	5	5	3	4	5	5	4	4	4	59.8
p25	4	5	4	5	5	3	4	5	5	61.4

Appendix H: Writing Task

Writing Task: Tablet Results

	2-1	2-2	2-3	2-4	2-5	2-6	2-7	2-8	2-9
p1:	3	4	4	5	4	2	4	4	213.2
p2:	4	4	3	5	4	3	4	5	245.4
p3:	5	5	4	4	4	2	4	4	248.0
p4:	4	3	4	5	3	2	3	4	259.0
p5	4	5	4	4	3	1	4	4	233.3
p6	4	4	4	4	5	2	4	5	267.5
p7	4	4	3	4	3	2	3	4	289.5
p8	3	4	5	4	4	2	5	5	301.2
p9	4	3	5	5	3	2	3	4	245.3
p10	5	5	4	4	5	1	4	4	229.2
p11	4	4	4	4	4	2	4	4	237.6
p12	4	3	4	4	4	2	4	5	241.3
p13	3	5	5	5	4	1	3	4	289.9
p14	4	3	4	4	4	2	4	4	265.1
p15	5	5	4	5	4	2	5	5	231.4
p16	5	5	4	4	4	1	4	4	289.4
p17	4	5	3	5	4	1	4	3	302.9
p18	4	5	5	4	4	1	5	4	245.8
p19	2	3	3	5	3	2	4	2	413.7
p20	4	3	4	4	4	2	5	4	238.0
p21	5	4	5	5	3	2	3	4	245.8
p22	5	4	4	4	5	2	4	5	287.6
p23	4	4	4	4	4	2	5	4	245.9
p24	5	5	5	4	4	2	4	5	234.1
p25	5	4	4	5	4	3	4	4	245.9

Writing Task: Smartphone Results

	2-1	2-2	2-3	2-4	2-5	2-6	2-7	2-8	2-9
p1:	3	4	4	5	5	2	4	4	220.2
p2:	4	4	3	4	4	3	5	5	240.3
p3:	5	5	4	4	4	2	4	4	251.7
p4:	5	4	5	5	4	1	4	5	254.3
p5	4	4	4	4	3	2	4	3	245.8
p6	3	4	4	5	4	2	4	5	254.9
p7	5	4	3	4	3	2	3	4	303.8
p8	4	3	5	4	4	3	4	4	291.9
p9	4	3	4	5	4	2	3	4	285.2
p10	5	5	4	4	5	1	4	5	228.9
p11	4	4	4	5	4	2	5	4	243.4
p12	4	3	4	4	4	2	4	4	239.2
p13	3	4	5	5	5	2	3	4	288.2
p14	5	3	4	4	4	2	4	4	291.1
p15	5	4	5	5	4	2	5	5	233.5
p16	4	5	4	4	5	1	4	4	285.2
p17	3	4	3	4	5	2	5	3	312.7
p18	4	5	5	4	4	1	5	4	255.8
p19	2	3	3	5	3	2	4	2	409.3
p20	4	4	4	4	4	2	4	4	248.2
p21	5	5	4	4	4	2	3	4	255.2
p22	4	4	4	4	4	1	4	4	281.0
p23	5	4	4	5	4	2	4	4	241.3
p24	5	4	5	5	5	2	4	4	224.9
p25	5	5	5	5	4	3	5	4	259.8

Appendix I: Direct Manipulation Results

Direct Manipulation Task: Tablet Results

	3-1	3-2	3-3	3-4	3-5	3-6	3-7	1-8
p1:	4	4	4	4	4	2	4	22.3
p2:	5	5	5	4	5	1	5	24.1
p3:	5	4	4	4	4	2	5	22.9
p4:	5	5	4	5	5	1	5	23.1
p5	4	5	5	4	4	2	4	21.0
p6	4	4	4	5	4	2	4	22.9
p7	5	5	4	4	3	1	4	24.8
p8	4	4	5	4	4	3	5	26.3
p9	5	4	4	4	4	1	3	21.8
p10	5	5	5	4	4	1	5	22.0
p11	5	4	4	5	5	2	5	22.3
p12	4	5	5	4	4	2	4	24.1
p13	4	4	5	5	4	2	4	21.3
p14	4	4	4	4	4	2	4	20.1
p15	5	4	5	4	4	1	5	19.8
p16	5	5	4	5	5	1	4	21.3
p17	4	4	4	4	4	2	4	22.4
p18	4	4	5	4	4	1	5	25.3
p19	3	3	3	5	3	3	3	22.8
p20	5	4	4	4	5	2	4	21.4
p21	4	4	4	4	4	2	4	22.3
p22	4	4	5	5	4	1	4	23.0
p23	5	5	5	4	5	1	5	21.7
p24	5	5	5	4	5	2	4	23.2
p25	5	4	5	4	4	2	5	21.9

Direct Manipulation Task: Smartphone Results

	3-1	3-2	3-3	3-4	3-5	3-6	3-7	3-8
p1:	5	5	5	5	4	1	5	22.0
p2:	5	5	5	5	4	1	5	23.8
p3:	4	4	4	5	4	2	4	21.9
p4:	5	5	5	5	5	1	5	22.1
p5	4	5	4	5	4	2	4	22.3
p6	5	4	4	4	4	1	5	23.1
p7	5	5	4	5	3	1	5	25.0
p8	4	4	4	4	3	2	4	25.9
p9	4	4	4	5	4	2	4	19.1
p10	5	5	5	5	4	1	5	21.1
p11	4	4	5	5	3	2	4	23.4
p12	4	4	5	4	3	2	4	23.0
p13	5	4	4	5	4	1	5	22.7
p14	4	5	5	5	4	3	4	21.8
p15	4	4	5	4	4	1	4	20.2
p16	4	5	4	5	5	2	4	20.9
p17	4	4	4	5	4	2	4	22.2
p18	5	4	4	4	4	1	5	24.8
p19	2	2	2	4	2	4	3	21.9
p20	5	5	4	4	4	1	4	21.2
p21	4	4	3	5	4	2	4	22.0
p22	5	5	4	5	5	1	5	22.3
p23	5	4	4	4	5	2	5	22.1
p24	5	5	5	5	4	1	5	23.1
p25	5	5	5	4	5	1	5	21.7

Appendix J: Camera Results

Camera: Tablet Results

	4-1	4-2	4-3	4-4	4-5	4-6	4-7	4-8
p1:	4	4	4	5	4	3	4	17.1
p2:	4	5	5	5	4	3	4	16.8
p3:	4	4	4	5	4	4	4	18.1
p4:	5	3	3	5	5	2	5	17.2
p5	3	2	2	5	4	4	3	18.3
p6	4	4	4	4	4	2	4	19.2
p7	4	4	4	5	4	2	4	17.3
p8	4	3	3	4	4	2	4	18.4
p9	3	3	4	5	4	3	3	18.7
p10	5	4	4	5	5	1	5	17.9
p11	4	2	2	5	4	2	4	19.2
p12	4	4	4	4	4	2	4	19.7
p13	3	4	4	5	4	3	3	19.4
p14	4	5	5	5	5	4	4	19.5
p15	4	4	4	4	5	2	4	18.5
p16	4	4	4	5	4	3	4	18.2
p17	4	4	4	5	4	4	4	18.4
p18	5	4	4	4	5	1	5	17.9
p19	2	3	3	4	4	3	3	20.1
p20	5	5	5	4	5	1	5	17.8
p21	4	4	4	5	4	4	4	18.3
p22	3	5	5	5	4	3	3	19.0
p23	5	4	4	5	5	1	4	18.6
p24	5	5	5	5	5	2	4	17.8
p25	4	4	4	5	4	3	4	18.3

Camera: Smartphone Results

	4-1	4-2	4-3	4-4	4-5	4-6	4-7	4-8
p1:	5	5	5	5	5	2	5	16.2
p2:	5	5	4	5	5	2	5	16.2
p3:	5	4	5	5	4	2	4	17.5
p4:	5	4	5	5	5	2	5	17.5
p5	4	4	5	4	4	3	4	17.7
p6	5	5	4	5	5	2	4	18.3
p7	5	4	5	5	5	2	5	17.5
p8	5	5	4	4	4	2	4	18.2
p9	5	4	5	4	5	3	4	17.9
p10	5	4	4	5	5	2	5	17.1
p11	5	5	4	4	5	2	4	18.8
p12	4	4	4	4	4	1	4	19.0
p13	5	4	5	5	4	3	3	18.8
p14	5	5	4	5	5	3	5	18.6
p15	5	4	4	5	5	2	4	17.9
p16	5	5	4	5	5	3	5	18.3
p17	5	5	5	5	5	2	5	18.1
p18	5	4	5	5	5	1	5	17.7
p19	4	4	3	4	4	3	4	19.7
p20	5	5	4	5	5	1	5	17.1
p21	5	5	5	5	5	3	4	18.1
p22	5	4	5	5	5	3	4	18.5
p23	5	5	4	5	5	1	4	18.4
p24	5	5	5	5	5	2	5	16.7
p25	5	5	5	5	5	3	4	17.2

Appendix K: Final Feedback Results

Final Feedback: Tablet Results

	5-1	5-2	5-3	5-4	5-5	5-6	5-7	5-8	5-9	5-10	5-11	5-12	5-13	5-14
p1:	4	4	4	4	5	4	1	4	1	1	3	4	1	1
p2:	4	5	4	4	4	5	2	4	1	1	3	3	2	1
p3:	5	5	4	5	5	5	1	5	1	1	4	4	1	2
p4:	4	5	4	4	4	4	2	4	2	2	3	4	2	1
p5	4	5	4	4	5	5	3	4	2	1	3	4	2	2
p6	3	5	3	3	4	4	1	4	2	2	3	4	2	3
p7	5	4	4	4	5	4	2	5	1	1	2	4	1	2
p8	4	5	4	4	5	4	2	4	2	2	3	3	1	1
p9	3	5	4	4	4	4	1	4	1	1	3	4	2	2
p10	4	5	5	5	4	4	2	5	2	1	4	3	1	1
p11	4	4	4	5	4	4	2	5	1	1	3	4	2	2
p12	5	4	5	5	4	4	1	5	1	1	3	3	2	1
p13	5	5	4	5	4	5	1	5	2	1	4	4	1	2
p14	5	5	5	4	5	4	1	5	1	2	3	4	2	1
p15	4	4	4	4	5	4	2	4	2	1	4	4	1	1
p16	4	5	5	4	4	5	1	5	2	2	4	3	2	2
p17	4	5	4	4	4	5	2	5	1	1	3	4	2	1
p18	4	4	5	4	4	4	2	5	2	1	3	3	1	1
p19	4	3	4	3	3	2	1	3	2	3	3	3	4	4
p20	4	4	5	4	4	4	2	4	1	1	2	3	2	2
p21	5	5	4	5	5	4	1	5	2	2	3	4	2	2
p22	5	5	5	5	5	4	3	5	2	1	3	4	1	1
p23	4	4	4	5	4	5	2	4	1	2	3	3	1	1
p24	5	5	5	4	5	4	1	5	2	1	2	4	1	1
p25	5	4	5	4	4	5	2	5	1	1	3	3	2	2

Final Feedback: Smartphone

	5-1	5-2	5-3	5-4	5-5	5-6	5-7	5-8	5-9	5-10	5-11	5-12	5-13	5-14
p1:	5	5	5	5	4	5	5	5	4	1	4	3	1	1
p2:	4	5	5	4	4	4	3	4	4	2	3	4	1	2
p3:	4	4	5	4	5	5	4	4	3	1	3	3	2	2
p4:	5	5	4	4	4	4	3	4	5	1	3	5	2	1
p5	4	5	5	4	4	4	4	4	4	2	3	3	1	1
p6	4	5	5	4	4	4	4	4	4	2	3	3	1	2
p7	4	4	4	4	5	5	2	4	5	1	3	4	2	1
p8	4	4	5	4	4	4	4	4	4	1	3	4	2	2
p9	4	5	5	4	4	4	4	4	4	1	2	4	2	2
p10	4	5	5	5	5	5	3	4	5	2	3	4	2	2
p11	4	5	5	4	4	4	4	4	4	1	3	4	2	2
p12	5	5	5	5	5	5	5	5	5	2	3	5	1	2
p13	3	4	4	3	4	4	3	4	4	1	3	4	1	1
p14	4	5	5	4	4	5	5	5	5	1	3	3	1	1
p15	4	5	5	4	5	4	3	5	4	2	3	4	2	2
p16	4	5	5	4	4	5	1	5	4	2	4	3	2	2
p17	5	5	4	5	4	5	2	5	5	1	3	3	2	1
p18	4	4	5	4	4	4	2	4	4	1	3	4	2	2
p19	3	3	5	2	2	2	3	3	4	3	2	2	5	4
p20	5	4	5	4	4	4	2	5	5	1	3	3	2	2
p21	4	4	5	5	5	4	5	5	4	2	3	4	1	1
p22	4	4	5	4	5	5	5	5	5	1	2	3	1	2
p23	5	5	5	5	5	5	5	5	4	2	3	5	2	1
p24	5	4	5	4	4	4	5	5	5	2	3	4	1	2
p25	4	4	5	5	4	4	4	5	4	1	3	3	1	1

Appendix L: Questionnaire Documents

(Included within supplemental files)

Appendix M: Consent Forms

(Included within Supplemental Files)