THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

COLLEGE OF INFORMATION SCIENCES AND TECHNOLOGY

A STUDY OF PERCEPTIONS AND BEHAVIORS RELATED TO SMARTPHONES AND MOBILE NETWORKS

JEFFREY M. DEAN
SPRING 2012

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Security and Risk Analysis
with honors in Security and Risk Analysis

Reviewed and approved* by the following:

Anna Squicciarini
Assistant Professor of Information Sciences and Technology
Thesis Supervisor

Peng Liu
Professor of Information Sciences and Technology
Director, Cyber Security Lab
Director, Lions Center
Honors Adviser

* Signatures are on file in the Schreyer Honors College

ABSTRACT

Smartphones are a rapidly evolving technology that continues to increase in popularity. With a great deal of corporate effort being spent upgrading smartphones and operating systems, it is important to understand the opinions of the general population and continue to educate them on new technologies and standards. Understanding the views and feelings of the public will allow phone and network providers to more efficiently provide current technologies and implement new technologies. This study provides an investigation of how the public views current networks and smartphone capabilities, as well as providing insight into how the general public understands these networks and their capabilities. The study also looks into how frequently individuals perform particular smartphone actions and whether or not they feel secure while performing those actions over different types of networks. The opening chapters will focus on an introductory background to networks and smartphone capabilities, followed by a short review of relevant literature. Following this is an examination of how knowledgeable individuals are about smartphones and their networks. The study then examines the frequency of actions performed using a smartphone and the level of security participants feel while performing these actions. Finally, the study examines how the factors of age, gender, current understanding of the networks and overall technical skill level affect opinions, perceptions, and actions taken by the participants.

Table of Contents

LIST OF FIGURES

K = Knowledge, P = Preference, S = Security, R = Rating, U = User frequency, D = Description

LIST OF TABLES

ACKNOWLEDGEMENTS

I would like to thank the following people for supporting me as I completed this process

- Anna Squicciarini
- Peng Liu
- Rick and Pam Dean

Chapter 1: Purpose

Smartphones continue to grow in popularity and expand in technical capabilities. Jason Langridge, the UK mobility business manager at Microsoft, defines smartphones as phones that "combine traditional communication devices and provide rich applications and rich data applications" (Best). In other words, a smartphone is a mobile phone that offers computer-like capabilities, which include a QWERTY keyboard, a touchscreen, a camera, GPS technology, access to the Internet and email, phone conversations, and texting.

With much effort being spent on creating new smartphones and improving current products, there exists little research focused on the knowledge and beliefs of the consumers and their effects on the way smartphones are used. It is crucial to understand consumer beliefs and knowledge because they can be instrumental to future consumer choices and company decisions. Knowledge of consumers' preferences and actions can help smartphone producers improve their phones and services, in addition to learning how the smartphones tend to be utilized. This study will aim to provide an insightful look into the above mentioned issues and begin a discussion about how opinions of smartphone and mobile network users could affect the direction of future products.

During my time studying cyber security and information technology as an undergraduate, I became interested in smartphones and the many functions that the technology provides. Mobile phone providers have their own networks for consumers, which allow for mobile Internet connections without the need for a stationary wireless or wired network. Smartphone users can now access the Internet from virtually anywhere at any given time. Because of this convenience and accessibility, smartphones have spread quickly from the workplace to households and to

college students and teenagers. In the United States, the number of smart phone users increased by 60% from 2010 to 2011, reaching 63.4 million, which accounted for over 25% of the total mobile phone users in the United States (Neo, 2011). According to a study done by Alex Wagner of PhoneDog, smartphones are now as commonly owned as non-smartphones, and will soon surpass non-smartphones, as the total number of smartphone users has eclipsed 101 million as of January, 2012 (Wagner). With the widespread and increasing use of smartphones and networks, it is more important than ever to understand how the public views and uses these technologies.

Chapter 2: Background of Smartphones and Networks

As the Internet grows in both size and accessibility, technological advances allow for greater and more mobile means of communication and data access. Computers became mobile with the invention of the laptop, and they continue to grow in power and shrink in size. Wi-Fi networks were implemented in the late 1990's. A Wi-Fi network is a computer network that allows for wireless exchange of data (Hitchcock). This technology allowed for wireless networks to infiltrate homes and even small businesses. With wireless internet access available to many, the next step was to create a handheld device that could access the Internet and essentially work as a small, mobile computer. At this time mobile phones were already very common, but technological advances allowed for new mobile phones to be smartphones. As smartphones evolve, they become more user-friendly and practical. Smartphone popularity boomed in businesses and in young adult age ranges. The percentage of adult users owning a smartphone increased from 35% in May of 2011 to 46% in February of 2012 (Smith). Similarly, the percentage of young adult (ages 18-24) smartphone users increased from 35% in Quarter 3 of 2010 to 54% in Quarter 3 of 2011 ("Generation App").

The technology surrounding these devices has also greatly improved. The first generation (1G) cellular network was operational in 1978. The network used transceivers to communicate with analogue mobile phones that could only support voice-calls ("1G - First Generation Networks"). The second generation (2G) cellular network was functional in the early 1990's. The major advancement was the use of digital technology that allowed for mobile phones to accept and send digital data. An improvement known as time division multiple access (TDMA) allowed for multiple users to use the systems. An example of a second generation system is Global

System for Mobile Communications (GSM) (Akhtar 3-5). These systems allowed for greater access to and exchange of data for mobile phones.

A cellular network now had a complex design. A mobile phone connected to the network through a wireless connection to a Base Station (BS). The Base Station would carry calls only inside its designated region. Mobile phones connected to different Base Stations as they entered new regions. Technology such as TDMA allowed the Base Station to communicate with the mobile station. Every BS connected to a Mobile Switching Center (MSC), which was connected to other MSCs by a Public Switched Telephone Network. The MSC handled switching mobile phones to connect with a new BS upon changing regions.

The third generation (3G) cellular network became functional in the early 2000's. Primary goals for this technology included much higher data exchange rates, increased capacity, and compatibility in different countries. These advancements allowed for the distribution of smartphones to a large portion of the population by ensuring the data exchanges could be handled sufficiently (Akhtar 4-6).

The fourth generation (4G) network is currently being implemented by most phone carriers and it does exist in a raw form in certain locations. The major advancements of this technology are massively increased data exchange rates and the ability for laptops to have mobile ultra-broadband Internet access through the use of Universal Serial Bus (USB) connection (Akhtar 6, 7).

Wi-Fi networks had been scrutinized for weak encryption and insecurity handling personally identifiable information that was exchanged over these networks. Recent advances have led to increased security of Wi-Fi networks with the implementation of WPA2, which is the

second generation of the WPA (Wi-Fi Protected Access) security protocol. A very strong password used on a WPA2 encrypted network would be very difficult to crack. However, WPA2 is not mandatory and many people still use the older encryptions, WPA or WEP (Wired Equivalent Privacy). These encryptions have many known weaknesses and should not be used (Lehembre 3-7). With the known intrusions into wireless networks, many appear to be switching to using mobile phone networks when possible. Unfortunately, with limited use of anti-virus and anti-malware programs for smartphones, it appears attackers are also making the change to mobile. A study by Symantec showed an increase of 42% in new mobile vulnerabilities from 2009 to 2010 (*Symantec Report Finds Cyber Threats Skyrocket in Volume and Sophistication*).

Mobile phone networks have appeared to be relatively safe compared to attacks on Wi-Fi networks. This is misleading, as attacks were uncommon on phone networks because they did not hold a large enough share of the market. Security on phone networks is largely lacking and the increasing popularity of smartphones makes them a good target for attackers (Lo). The majority of current attacks against mobile devices were Trojan Horse programs. A Trojan Horse is defined as a "malicious, security-breaing program that is disguised as something benign" (Lo). An example of a Trojan Horse could be downloading what one would think is a picture or a music file, when in reality the download was a dangerous program that allows the stranger to spy on your actions, control your system, retrieve any stored credit card numbers and passwords, and even use your machine to attack others (Lo). Trojan Horses are used against mobile devices by posing as real mobile applications. (Lo). Easy distribution of mobile applications through app stores allows for quick and effective movement of the Trojan Horse program to unsuspecting users.

Chapter 3: Literature Review

Research on the topic of networks and mobile device behaviors is limited. It is a relatively new and specific topic. One study provides some insight into the area of interest. The purpose of this study was to determine why smartphone users choose to use a specific type of network. The researchers were interested in what activities people accessed Wi-Fi networks to engage in and when people accessed the same networks via mobile phone connection and what activities were noticed then (Afanasyev, Chen, Voelker, & Snoeren, (2010). This research only compared activity conducted using desktops and laptops over Wi-Fi networks to activities conducted using mobile phones over the same networks; there was no inclusion of 3G in this study and 4G had not yet existed operationally. The experiment was conducted using the Google Wi-Fi network that is deployed in Mountain View, CA. Researchers collected overall network statistics for analysis over a period of 28 days. The usage was broken down according to the type of device that was connected to the network and where the connection took place (i.e. on a subway, in a coffee shop). It was found that modem connections are static and place the greatest demand on the network (Afanasyev et. al.). Hotspot users (i.e. coffee shops) were found to be concentrated in commercial areas and have moderate mobility. Smartphone users were found to be "surprisingly numerous" and had peak activity that correlated with commute times, yet placed low demands on the network (Afanasyev et. al.). This is relevant to the current study because the data suggests the use of mobile devices to access the network is a convenience factor; people access the network via their mobile phones because they are traveling and may have no other means by which to connect to the network. It was also relevant to see that the mobile device access placed lower demands on the network. The major limitation of this study was found to be an inability to extrapolate the results they found to other networks. This study serves as a strong

beginning point into further research regarding user preferences with mobile phones and networks.

Another study aimed to discover what constitutes typical smartphone user activity and how it varies across users (Shye, Scholbrock, Memik, & Dinda, (2010). Researchers conducted a 6-month experiment that involved 52 users operating a specific smartphone, the Android G1. The researchers posted online advertisements and physical flyers on university campuses, on web sites, and on Android-related forums (Shye et. al.). With the appropriate permissions and consents, they collected logs from 52 users and used data from the 25 users with the longest total recorded time. Despite the consistency of the particular smartphone in use, the research showed that usage patterns varied greatly across the population, which means that the use of smartphones depends greatly on the user (Shye et. al.). These results demonstrate the importance of collecting data about the users and their feelings about using specific functionalities of smartphones.

Chapter 4: Methodology

This study attempts to discover people's general understanding of smartphones and networks, as well as their feelings and beliefs about the technology. In addition, the study attempts to analyze the manners in which people tend to use the technology. This study was conducted solely using survey-based methodologies. Data was collected using a survey that was created and presented in an online format through SurveyMonkey (http://www.surveymonkey.com). Demographics and basic background information were also collected as part of the survey. The survey was distributed through the use of email lists and classroom visits.

The survey, which can be found in Appendix A, was divided into five main sections. The first section collected demographics and basic background knowledge questions. Age range and gender were also collected. Basic technical skill was also collected. These results were collected in order to analyze each as an independent variable for the statistical analysis of the survey results.

The second section of the survey contained many opinion statements. All were delivered in the form of a five-point Likert scale. A response of one was labeled as "Strongly Disagree", a response of three was labeled as "Neither Agree nor Disagree", and a response of five was labeled as "Strongly Agree". These statements were all intended to assess the participants' feelings towards the mobile networks as well as towards conducting particular actions using their smartphones (i.e. texting, mobile banking, web browsing, etc.). A neutral value of three (neither agree nor disagree) was used for each of the 5-point Likert scale responses when conducting a

one-sample t-test in order to determine if any of the means were significantly different from the neutral value.

The third section gathered information about the frequency at which the participant performs particular actions using their smartphone. The actions that were included were texting, email, web browsing, mobile banking, buying/selling/trading stock, E-commerce, social networking, and use of mobile applications. These are the main actions that can be performed on a smartphone over a mobile network. These responses were gathered on a 5-point scale with a response of one labeled as “Never”, a response of two labeled as “Rarely”, a response of three labeled as “Once or twice a week”, a response of four labeled as “Daily”, and a response of five labeled as “Several times daily”. This information was gathered for analysis in order to determine how frequently people perform each of the actions of interest, if at all.

The next section served to collect information regarding preference of network, specifically whether participants liked using 3G/4G networks or Wi-Fi networks and the reasons for their preference. Multiple answers were allowed so participants could choose many reasons for their use of each network. The options that were consistent across both types of network were “Convenience”, “Speed”, “Security”, “Trust”, “Lack of trust (in the other type of network)”, “Personal Preference”, and “Other”. There was also an option that allowed participants to indicate that they did not have either a Wi-Fi or a 3G/4G connection available, in addition to an option that states they do not use that particular type of network. This section is important to the analysis because the information can be used to show not only that a preference of network exists, but to detail the reasons for the particular preference of network.

The final section collected information about the participants' feelings of security when performing the aforementioned actions using their smartphones. Participants were then asked to describe the precautions they take before performing any of the actions, if any. If the participants answered that they take no precautions, they were then asked to provide reasoning for the lack of precaution. This section is useful in determining how the participants feel about the actions, whether or not they perform them, and then provides insight into why they feel they either do or do not need to take security measures beforehand.

A total of 67 responses were started with the SurveyMonkey online survey tool. 62 of those responses were successfully completed. A successfully completed survey consisted of answering the first fourteen questions, at least having viewed the fifteenth question, and then clicking on the final "Done" button at the end of the survey. An exception to these completion criteria was completing the first three questions and answering the third question with "I do not own a smartphone". There were seven such results.

These responses were broken down into groups based on the demographics questions to determine if age or gender was a significant variable. The mean for each response was compared across the groups within each demographic. Males and females were compared using a two-sample t-test with a pooled standard deviation. Age groups were to be compared using a one-way ANOVA. The three different levels of technical skill level were compared using a one-way ANOVA. Background knowledge of 3G and 4G networks and Wi-Fi networks were also compared using one-way ANOVAs. Using demographics and background knowledge to compare means allows insight into the factors that could affect the opinions, actions, and frequency of actions of an individual with a smartphone.

Chapter 5: Results

Table 1 represents each of the questions from the survey. This numbering system will be used to identify these statements for the remainder of the research paper and in any related tables. K statements are knowledge statements. S statements are statements related to user security. P statements deal with user preferences. R statements are related to the users' rated levels of security and safety in particular situations. The U statement is related to users' frequency of performing actions. D statements are related to users describing their reasons for choosing a particular network over the other.

Statistical analysis using one-sample t-tests for each of the statements are shown in Table 2. The first three knowledge statements were only assessed on a scale of 1-3.. Those t-tests were conducted using a null hypothesis with the mean being equal to two; the alternative hypothesis was that the mean was not equal to two. For every other statement, the null hypothesis was that the mean was equal to three; the alternative hypothesis was that the mean was not equal to three. All t-tests were conducted at a 95% confidence level (α=0.05). 24 of the statements returned statistically significant results that led to rejection of the null hypothesis, while eight statements did not return statistically significant results, and the null hypothesis could not be rejected. The eight statements that did not show significant results were K4, P2, S8, S9, R4, R12, R13, and R14. The U statement and D statements were not tested for significance. They were collected and used to give a visual description of results.

Table 1. Survey Questions

Statement	Number
How would you rate your overall understanding of Wi-Fi Networks?	K1
How would you rate your overall understanding of 3G/4G Networks?	K2
How would you rate your overall technical skill level?	K3
3G/4G networks are more convenient than Wi-Fi networks for smartphone use	P1
3G/4G networks are more secure than Wi-Fi networks	K4
I prefer using Wi-Fi networks over using 3G/4G networks	P2
I feel safe using a Wi-Fi networks that does not require a password	S1
I feel safe using Wi-Fi networks that are password protected because they are safer than 3G/4G networks	S2
I feel safe using 3G/4G networks because the phone carrier can be trusted	S3
I feel safe when sending and receiving text messages on my smartphone	S4
I feel safe when using mobile applications (apps) on my smartphone	S5
I feel safe when using social networking sites on my smartphone	S6
I feel safe when buying/selling/trading stock from my smartphone	S7
I feel safe when making online purchases from my smartphone	S8
I feel safe when mobile banking from my smartphone	S9
I feel safe when sending and receiving emails from my smartphone	S10
Rated level of security/safety over 3G/4G networks when texting	R1
Rated level of security/safety over 3G/4G networks when emailing	R2
Rated level of security/safety over 3G/4G networks when web browsing	R3
Rated level of security/safety over 3G/4G networks when mobile banking	R4
Rated level of security/safety over 3G/4G networks when buying/selling/trading stock	R5
Rated level of security/safety over 3G/4G networks when making online purchases (E-Commerce)	R6
Rated level of security/safety over 3G/4G networks when using social networking sites	R7
Rated level of security/safety over 3G/4G networks when using mobile applications (apps)	R8
Rated level of security/safety over Wi-Fi networks when texting	R9
Rated level of security/safety over Wi-Fi networks when emailing	R10
Rated level of security/safety over Wi-Fi networks when web browsing	R11
Rated level of security/safety over Wi-Fi networks when mobile banking	R12
Rated level of security/safety over Wi-Fi networks when buying/selling/trading stock	R13
Rated level of security/safety over Wi-Fi networks when making online purchases (E-Commerce)	R14
Rated level of security/safety over Wi-Fi networks when using social networking sites	R15
Rated level of security/safety over Wi-Fi networks when using mobile applications (apps)	R16
Frequency users perform specific actions on their smartphone	U1
Descriptions of reasons for using Wi-Fi networks	D1
Descriptions of reasons for using 3G/4G networks	D2

Table 2. Statistical Analysis of Responses

Statement	N	Mean	Standard Deviation	t	p
K1	62	2.1935	0.6736	2.26	0.027
K2	62	1.7419	0.6256	-3.25	0.002
K3	62	2.4677	0.5030	7.32	0.000
K4	55	3.127	0.862	1.10	0.278
P1	55	3.618	1.209	3.79	0.000
P2	55	3.091	1.266	0.53	0.597
S1	55	2.345	1.294	-3.75	0.000
S2	55	3.4182	0.7376	4.20	0.000
S3	55	3.273	0.849	2.38	0.021
S4	55	4.036	0.793	9.70	0.000
S5	55	3.855	0.803	7.89	0.000
S6	55	3.655	1.022	4.75	0.000
S7	55	2.673	0.904	-2.69	0.010
S8	55	2.891	1.117	-0.72	0.472
S9	55	3.036	1.186	0.23	0.821
S10	55	4.145	0.756	11.24	0.000
R1	55	4.600	0.655	18.10	0.000
R2	55	4.3818	0.7069	14.50	0.000
R3	55	4.291	0.854	11.22	0.000
R4	55	2.909	1.251	-0.54	0.592
R5	55	2.400	1.029	-4.32	0.000
R6	55	2.618	1.130	-2.51	0.015
R7	55	4.091	0.986	8.20	0.000
R8	55	4.345	0.865	11.53	0.000
R9	55	4.436	0.788	13.52	0.000
R10	55	4.418	0.762	13.80	0.000
R11	55	4.400	0.784	13.24	0.000
R12	55	3.182	1.172	1.15	0.255
R13	55	2.764	1.036	-1.69	0.096
R14	55	3.000	1.139	0.00	1.000
R15	55	4.182	0.964	9.09	0.000
R16	55	4.364	0.868	11.64	0.000
U1	55	3.3886	0.4185	N/A	N/A
D1	133	N/A	N/A	N/A	N/A
D2	121	N/A	N/A	N/A	N/A

Three of the four knowledge-based statements (K1-K4) had significant results. K1 had a significantly positive result (mean greater than two) while K2 had a significantly negative result (mean less than two). K3 had a strongly positive result, and K4 did not have any statistically significant result. The t and p-values for these statements can be found in Table 2.

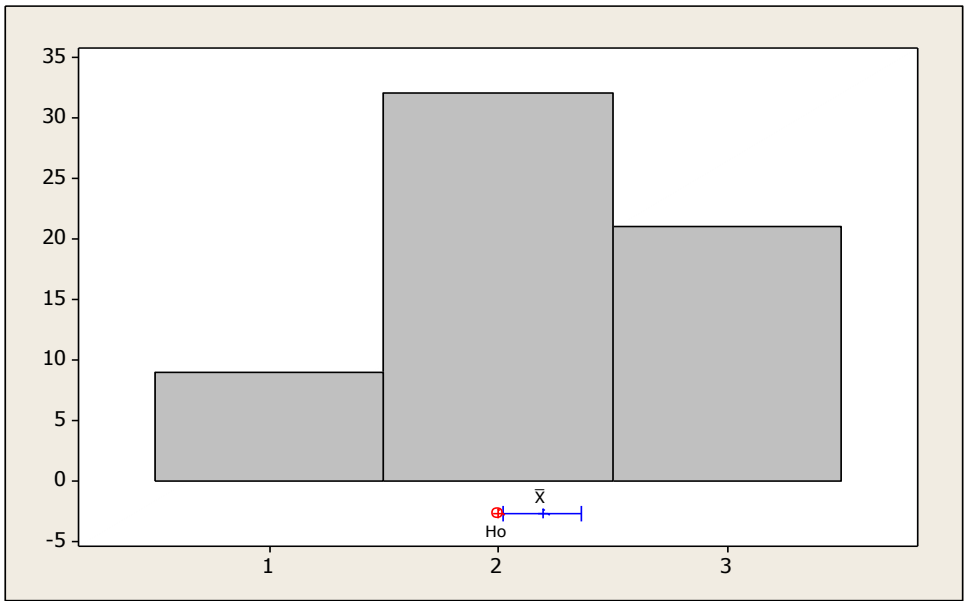

Figure 1. Histogram of responses to statement K1: How would you rate your overall understanding of Wi-Fi Networks?

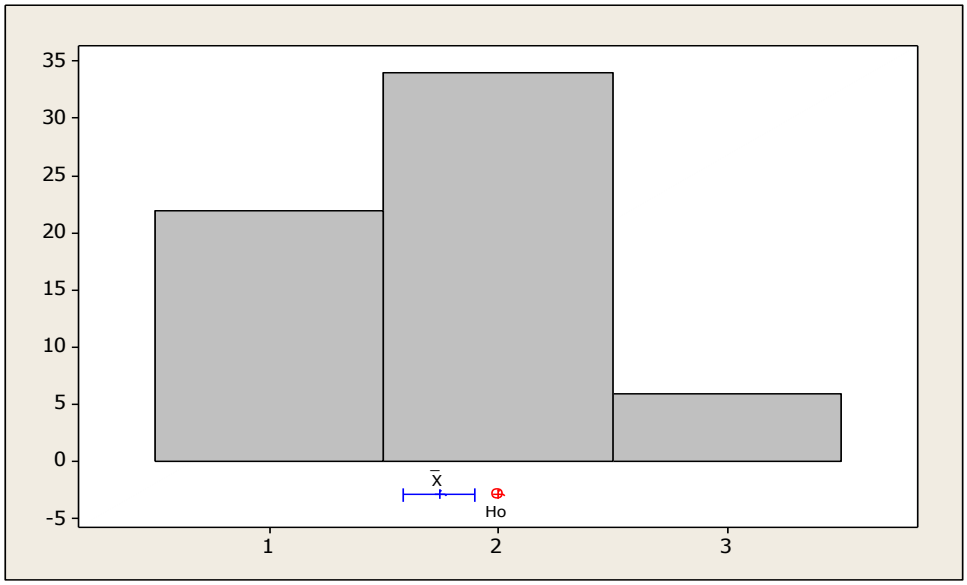

Figure 2. Histogram of responses to statement K2: How would you rate your overall understanding of 3G/4G Networks?

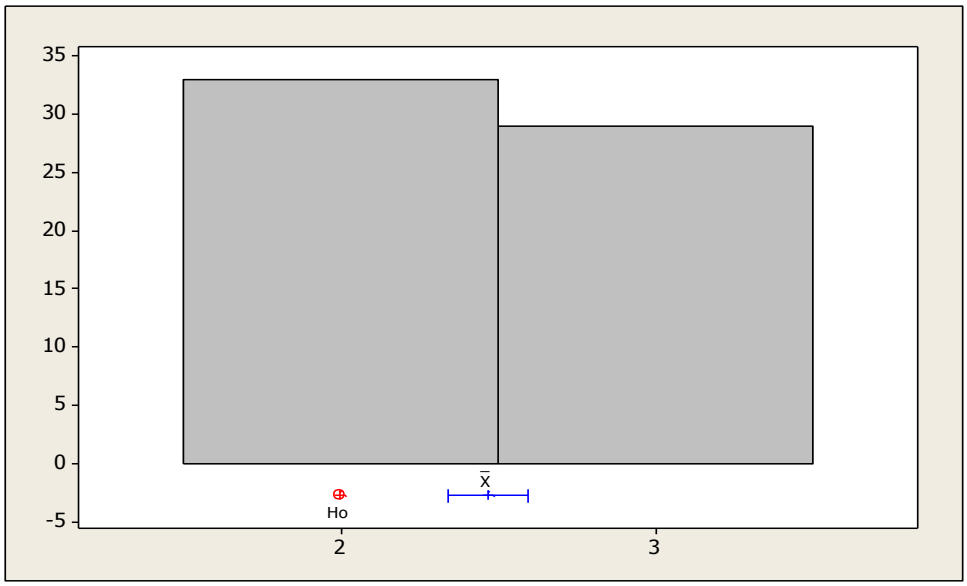

Figure 3. Histogram of responses to statement K3: How would you rate your overall technical skill level?

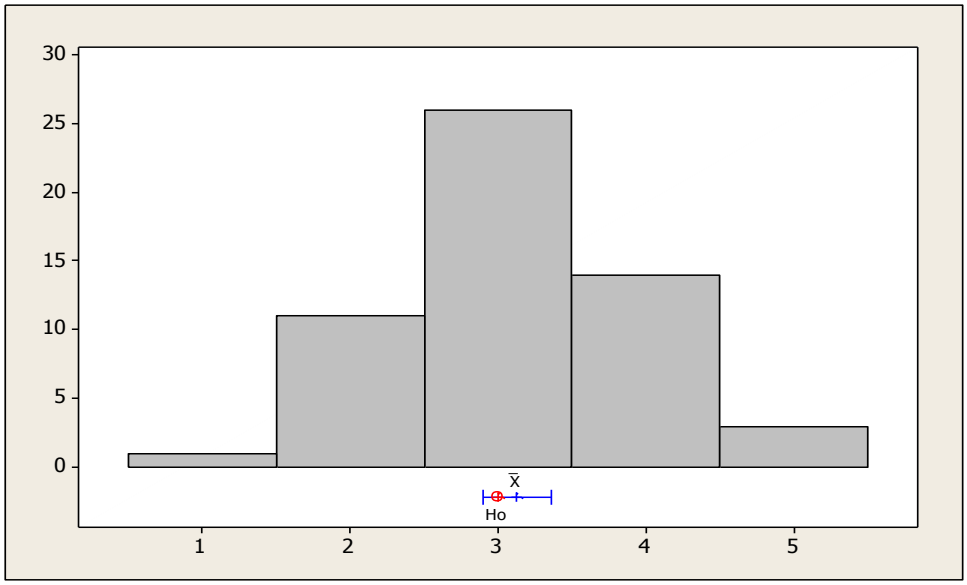

Figure 4. Histogram of responses to statement K4: 3G/4G networks are more secure than Wi-Fi networks

Visual analysis of the response distributions for these four statements supports the results of the statistical analysis. Figures 1 and 3 show a positive skew for both statements K1 and K3. Figure 2 shows a negative skew for statement K2, and Figure 4 shows a nearly normal distribution for statement K4.

One of the two preference-based statements (P1-P2) had a significant result. P1 had a significantly positive result, while P2 did not have a statistically significant result. T and p-values can be found in Table 2.

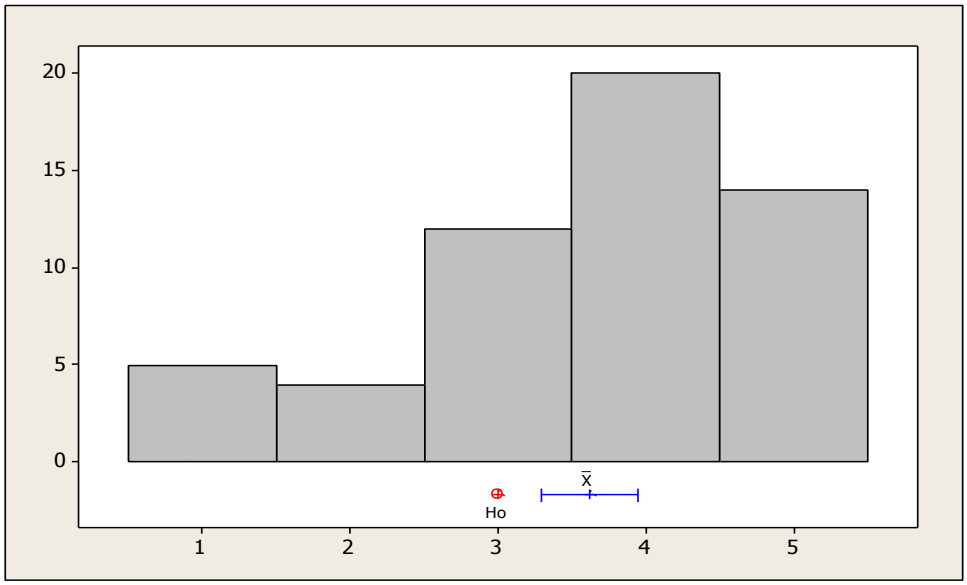

Figure 5. Histogram of responses to statement P1: 3G/4G networks are more convenient than Wi-Fi networks for smartphone use

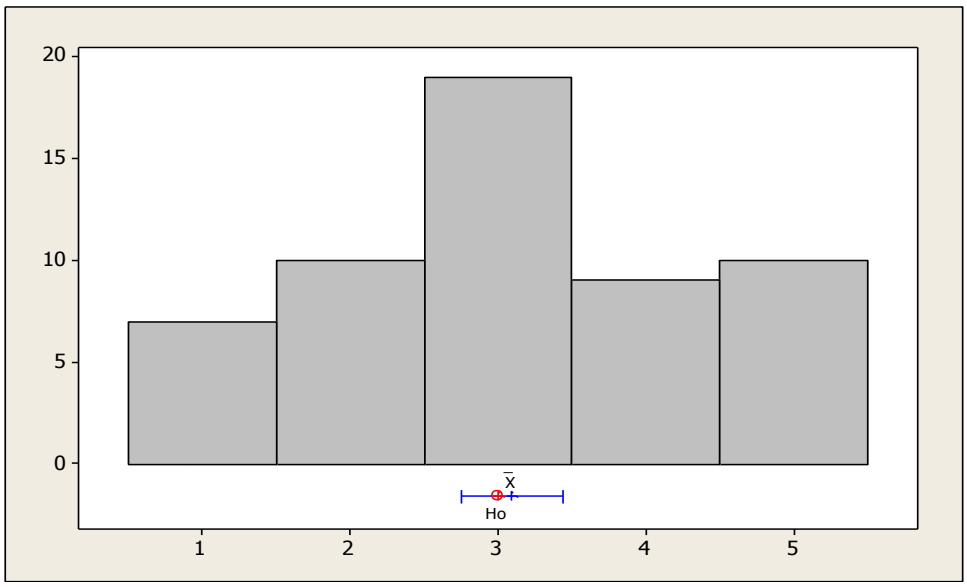

Figure 6. Histogram of responses to statement P2: I prefer using Wi-Fi networks over using 3G/4G networks

Visual analysis of the distributions of responses for these two statements supports the statistical analysis. In Figure 5, a strong positive skew is noticed for statement P1. Figure 6 has a distribution that is close to normal for statement P2.

Eight of the ten security-based statements (S1-S10) had significant results. Statements S1, S2, S3, S4, S5, S6, S7, and S10 had significant results, while statements S8 and S9 showed no significant results. S1 and S7 had statistically negative results. S2, S3, S4, S5, S6, and S10 had statistically positive results. T and p-values can be found in Table 2.

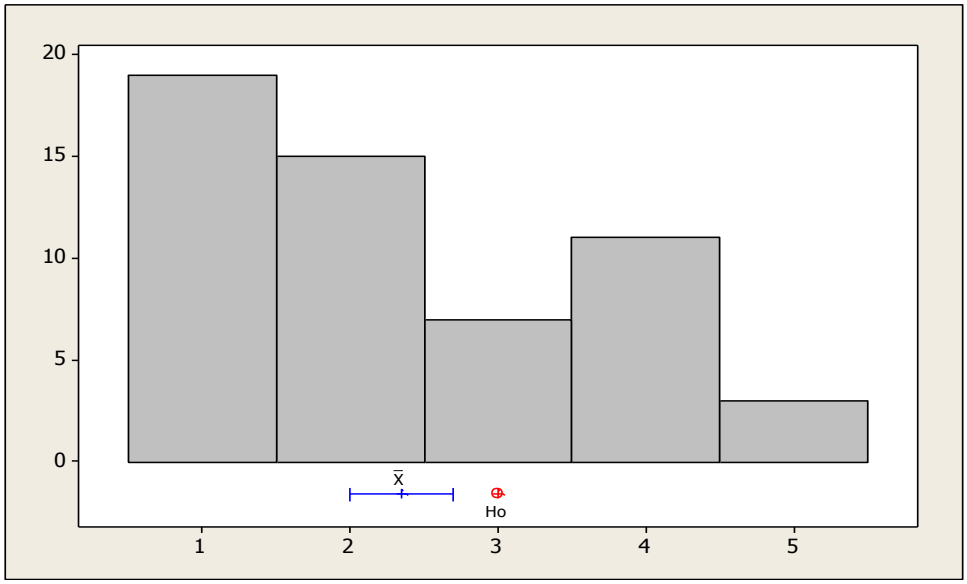

Figure 7. Histogram of responses to statement S1: I feel safe using a Wi-Fi network that does not require a password

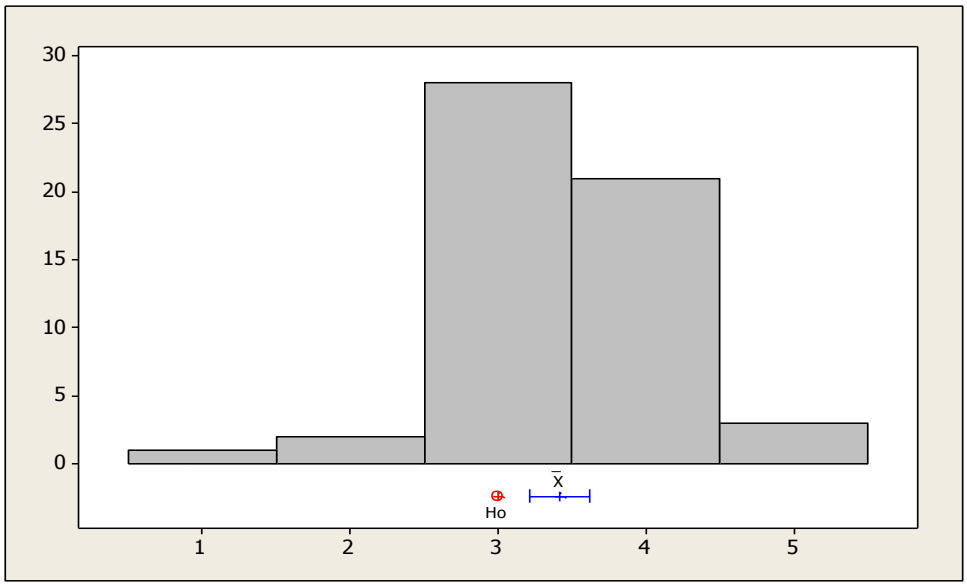

Figure 8. Histogram of responses to statement S2: I feel safe using Wi-Fi networks that are password protected because they are safer than 3G/4G networks

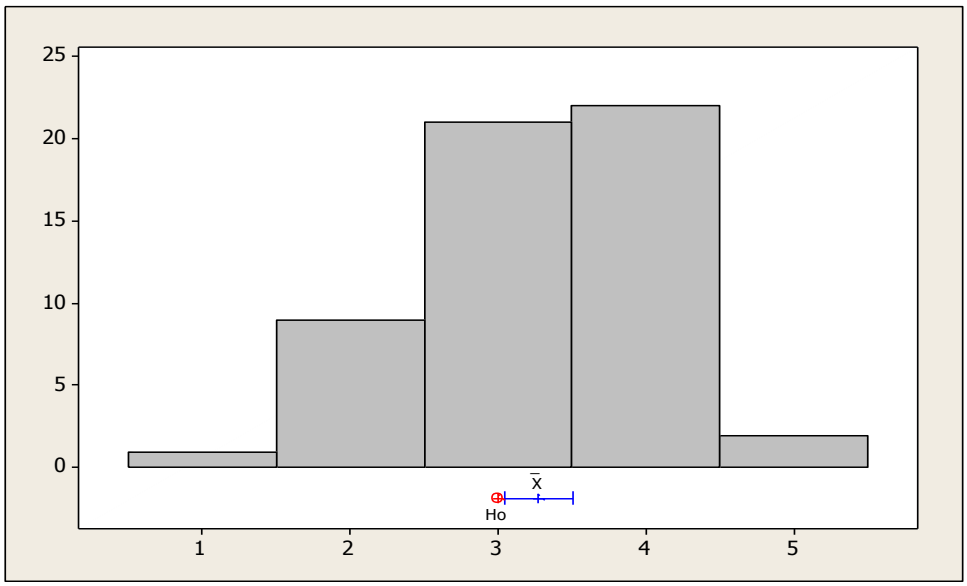

Figure 9. Histogram of responses to statement S3: I feel safe using 3G/4G networks because the phone carrier can be trusted

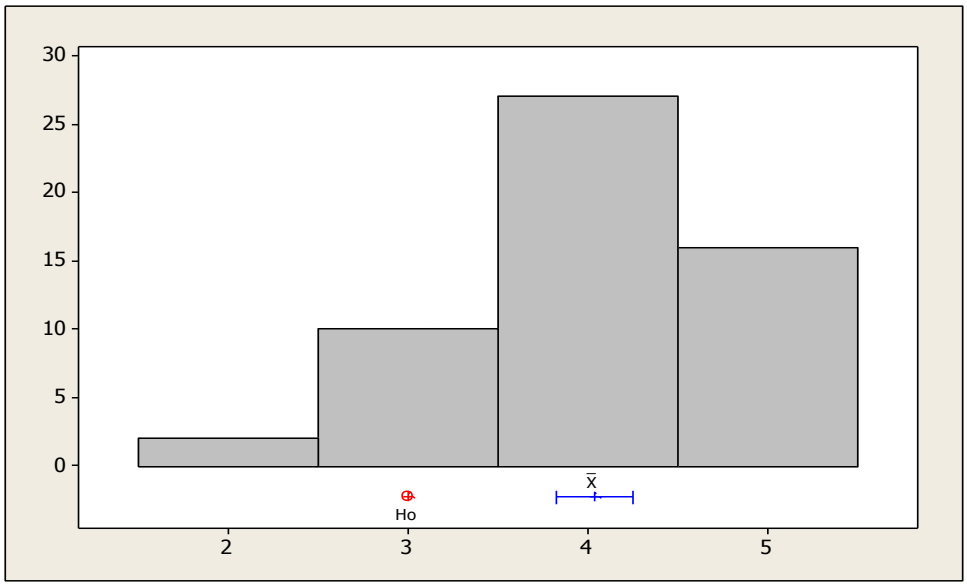

Figure 10. Histogram of responses to statement S4: I feel safe when sending and receiving text messages on my smartphone

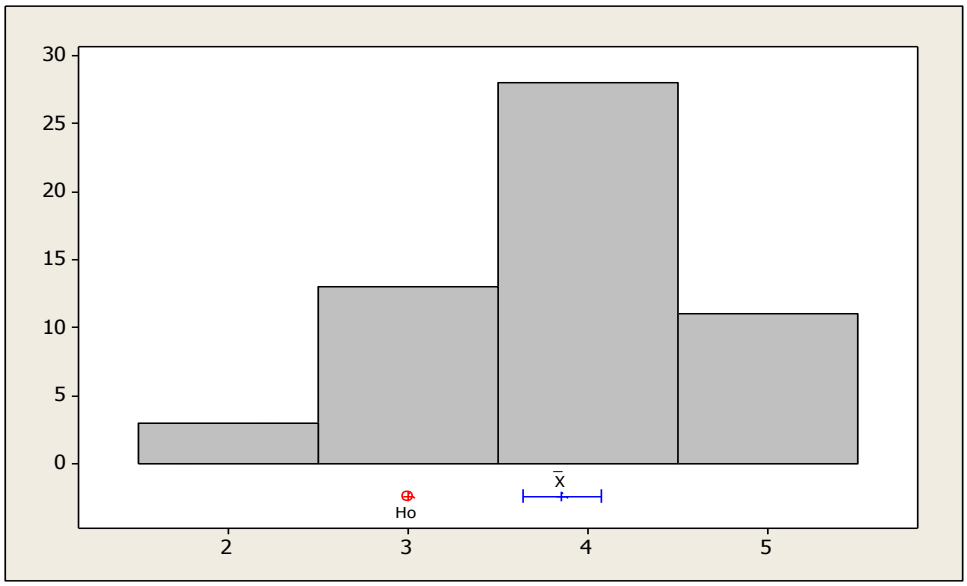

Figure 11. Histogram of responses to statement S5: I feel safe when using mobile applications (apps) on my smartphone

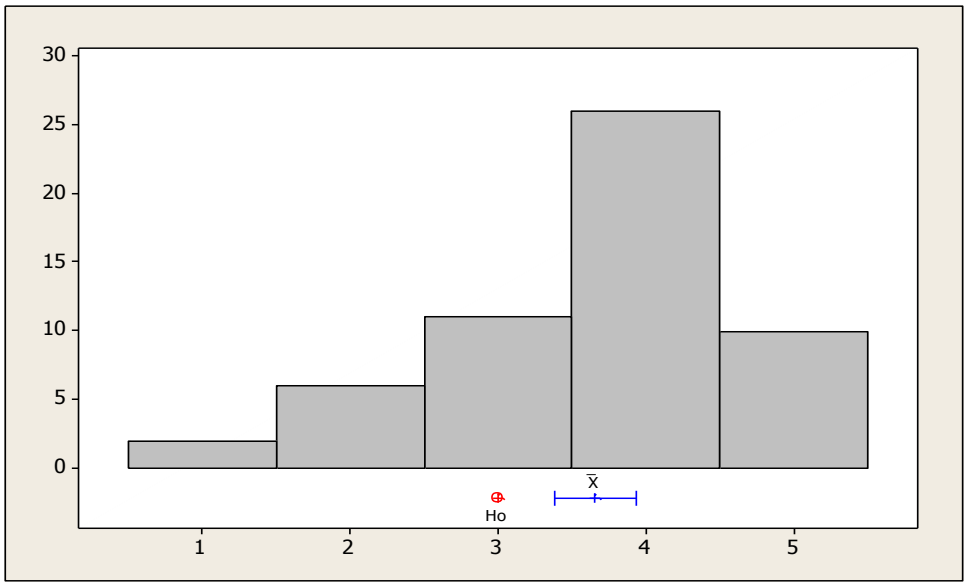

Figure 12. Histogram of responses to statement S6: I feel safe when using social networking sites on my smartphone

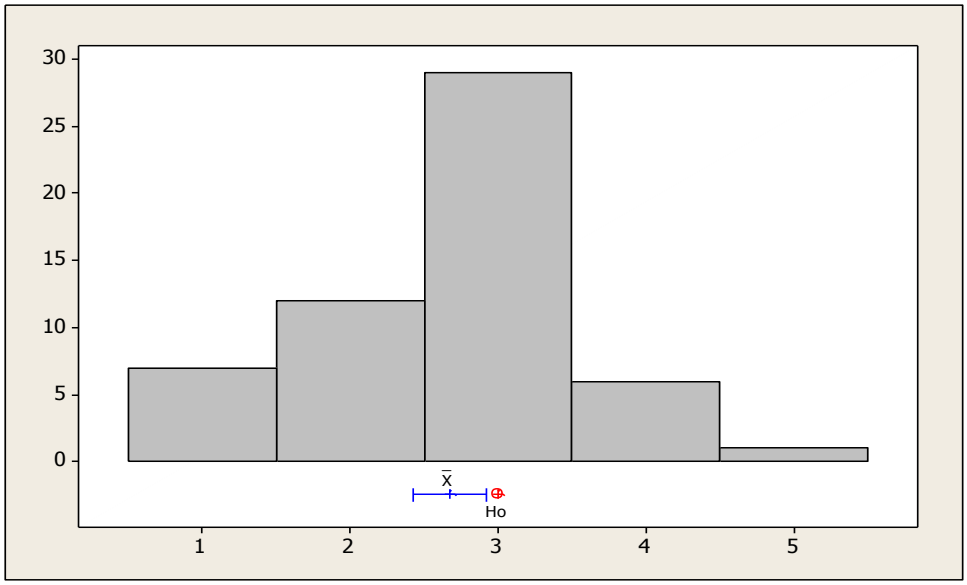

Figure 13. Histogram of responses to statement S7: I feel safe when buying/selling/trading stock from my smartphone

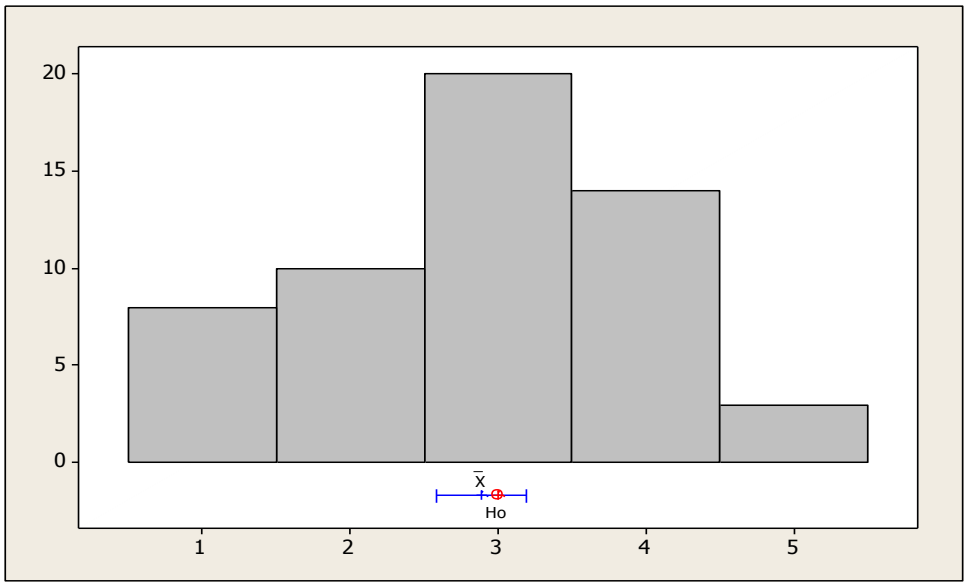

Figure 14. Histogram of responses to statement S8: I feel safe when making online purchases from my smartphone

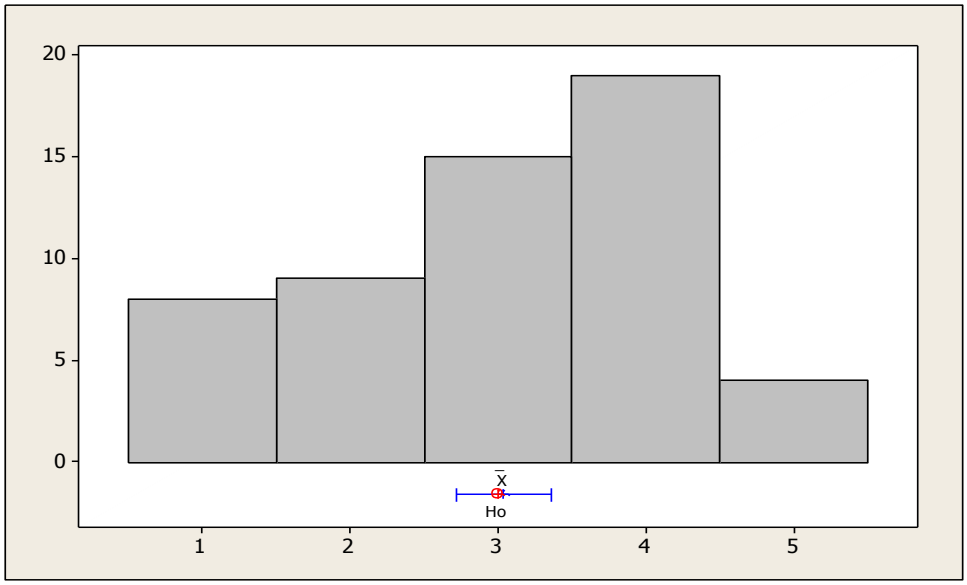

Figure 15. Histogram of responses to statement S9: I feel safe when mobile banking from my smartphone

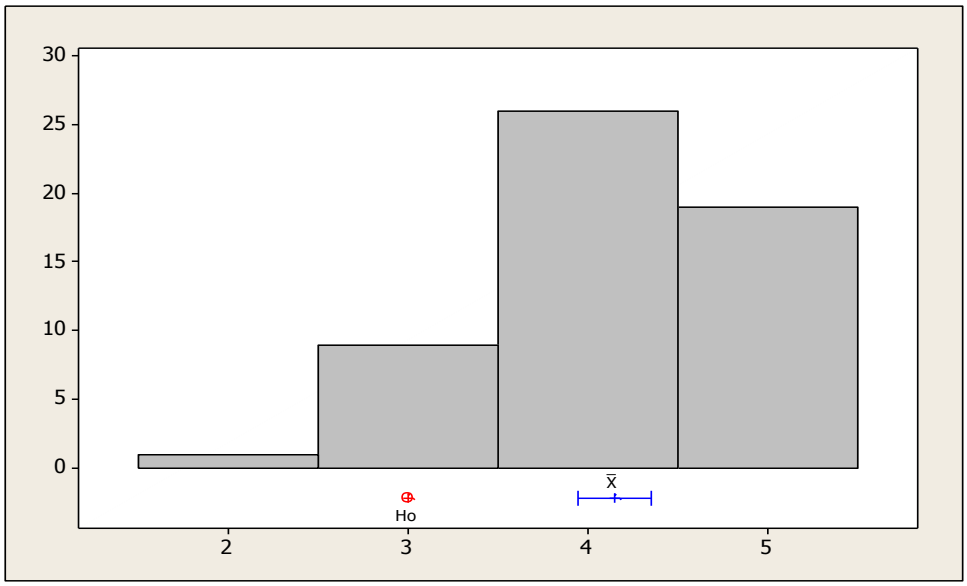

Figure 16. Histogram of responses to statement S10: I feel safe when sending and receiving emails from my smartphone

Visual analysis of the histogram distributions supports the results of the statistical analysis. Figures 7 and 13 show that statements S1 and S7 had a negative distribution that is skewed to the left. Figures 8, 9, 10, 11, 12, and 16 show that statements S2, S3, S4, S5, S6, and S10 had positive distributions that are skewed to the right. The negative skew parallels responses that tended toward "disagree" as the most common response. The positive skew results related to the responses that tended toward statements that had more "agree" responses. Figures 14 and 15 show that statements S8 and S9 had a distribution that does not strongly favor one side or the other, with the responses often favoring "neither agree nor disagree".

Statistical analysis revealed that twelve of the sixteen user rating-based statements had statistically significant results. Figures 17, 18, 19, 23, 24, 25, 26, 27, 31, and 32 show that statements R1, R2, R3, R7, R8, R9, R10, R11, R15, and R16 had statistically significant results on the agreement side of the scale (greater than three). Each of these statements had a mean that was between four (agree) and five (strongly agree). Figures 21 and 22 show that statements R5 and R6 had statistically significant results on the disagree side of the scale (less than three) with

the mean responses falling between two (disagree) and three (neither agree nor disagree). Figures 20, 28, 29, and 30 show that statements R4, R12, R13, and R14 did not have statistically significant results. T and p-values can be found in Table 2.

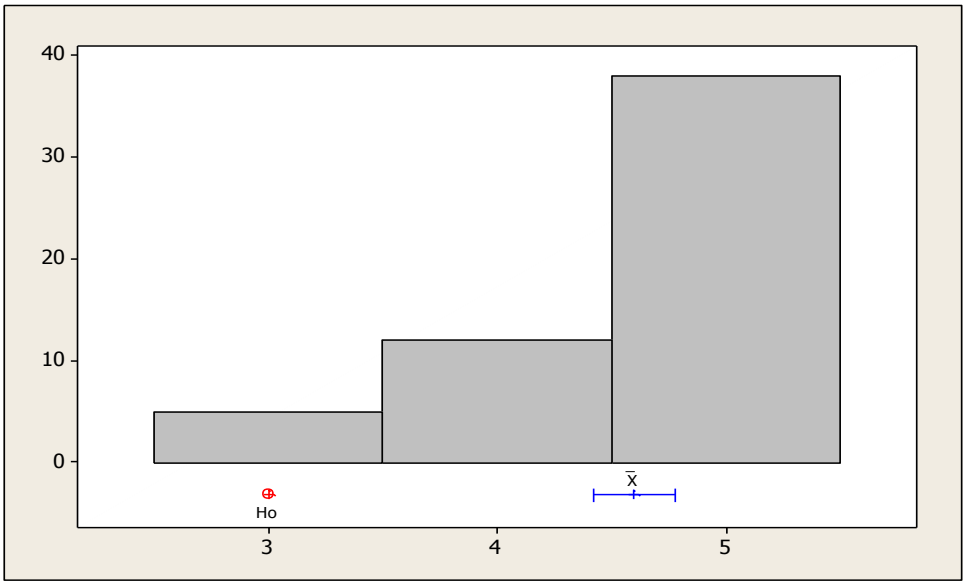

Figure 17. Histogram of responses to statement R1: Rated level of security/safety over 3G/4G networks when texting

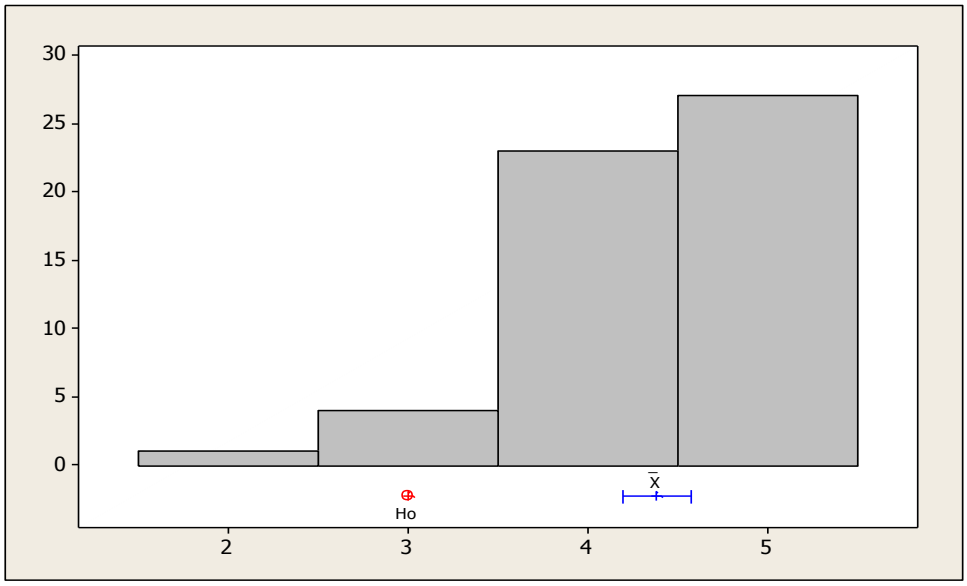

Figure 18. Histogram of responses to statement R2: Rated level of security/safety over 3G/4G networks when emailing

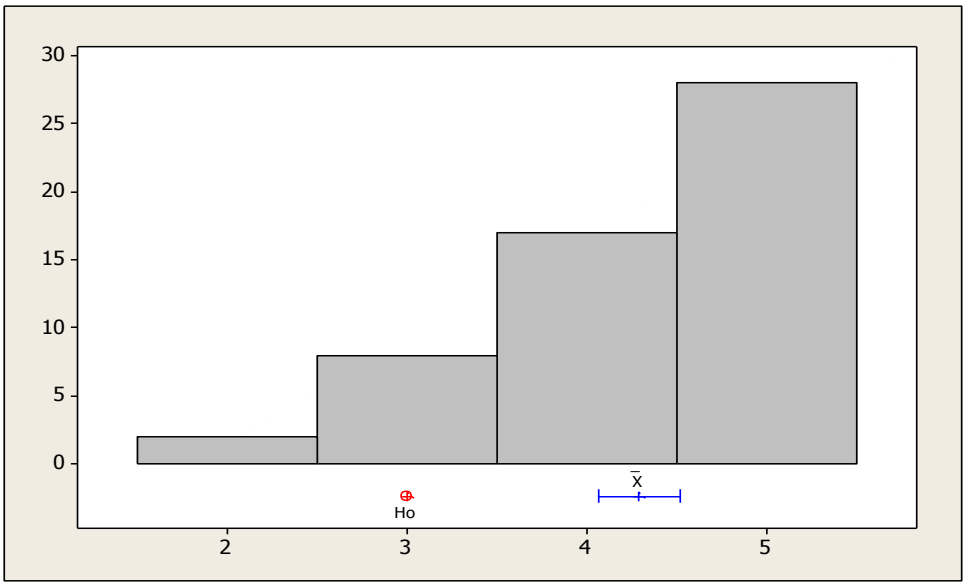

Figure 19. Histogram of responses to statement R3: Rated level of security/safety over 3G/4G networks when web browsing

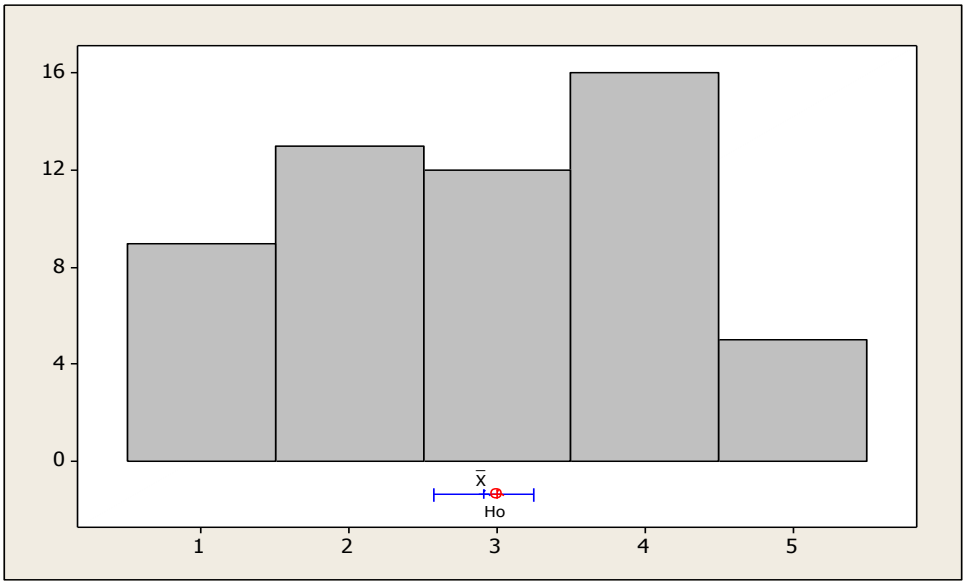

Figure 20. Histogram of responses to statement R4: Rated level of security/safety over 3G/4G networks when mobile banking

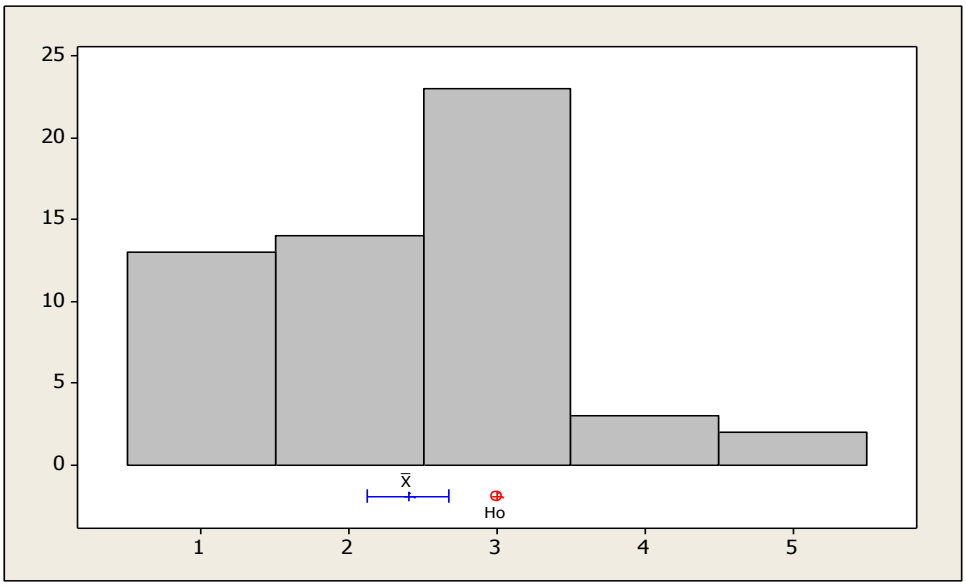

Figure 21. Histogram of responses to statement R5: Rated level of security/safety over 3G/4G networks when buying/selling/trading stock

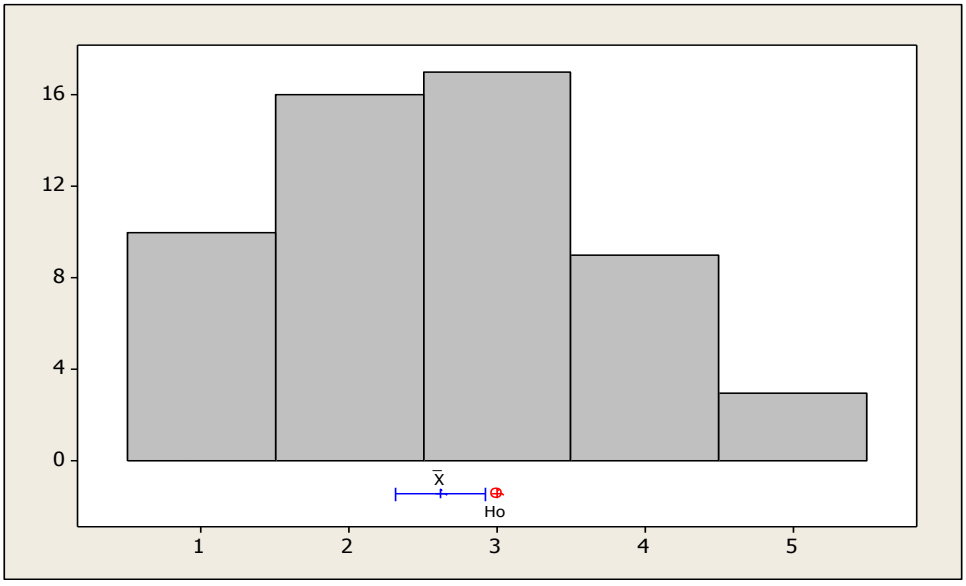

Figure 22. Histogram of responses to statement R6: Rated level of security/safety over 3G/4G networks when making online purchases (E-Commerce)

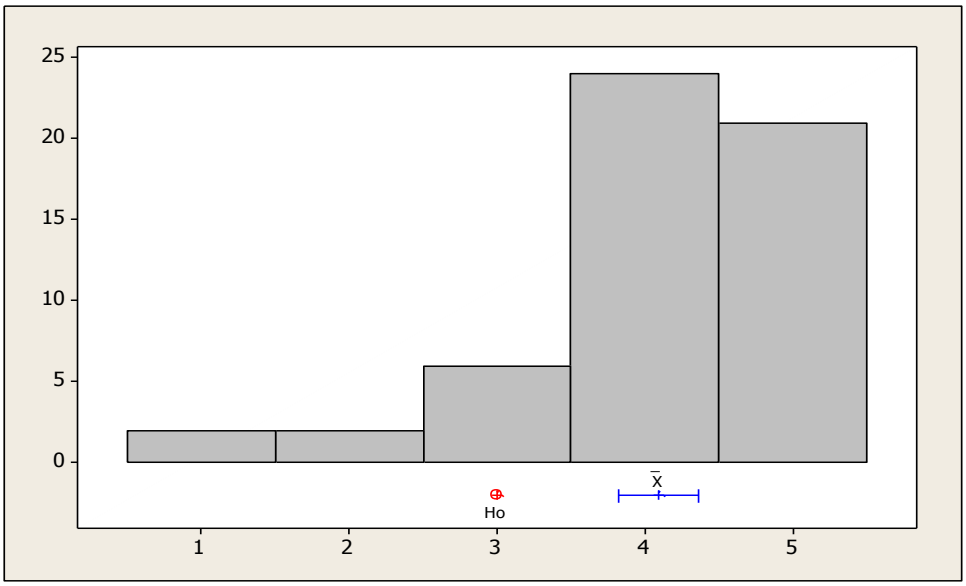

Figure 23. Histogram of responses to statement R7: Rated level of security/safety over 3G/4G networks when using social networking sites

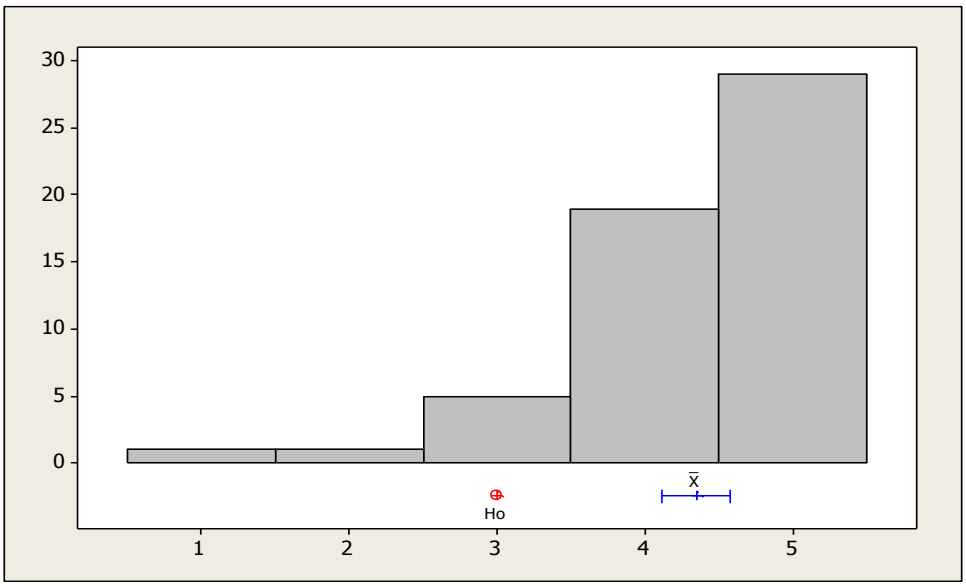

Figure 24. Histogram of responses to statement R8: Rated level of security/safety over 3G/4G networks when using mobile applications (apps)

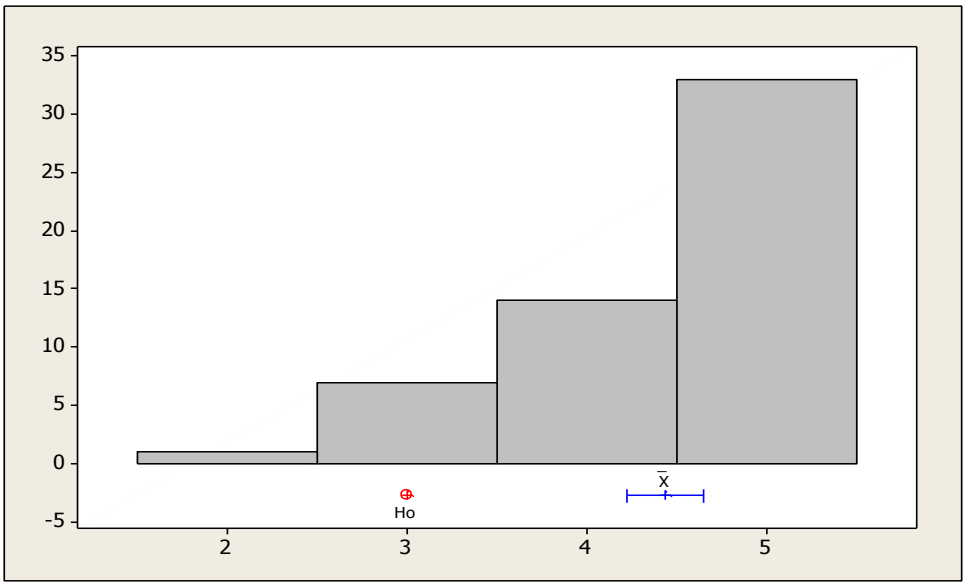

Figure 25. Histogram of responses to statement R9: Rated level of security/safety over Wi-Fi networks when texting

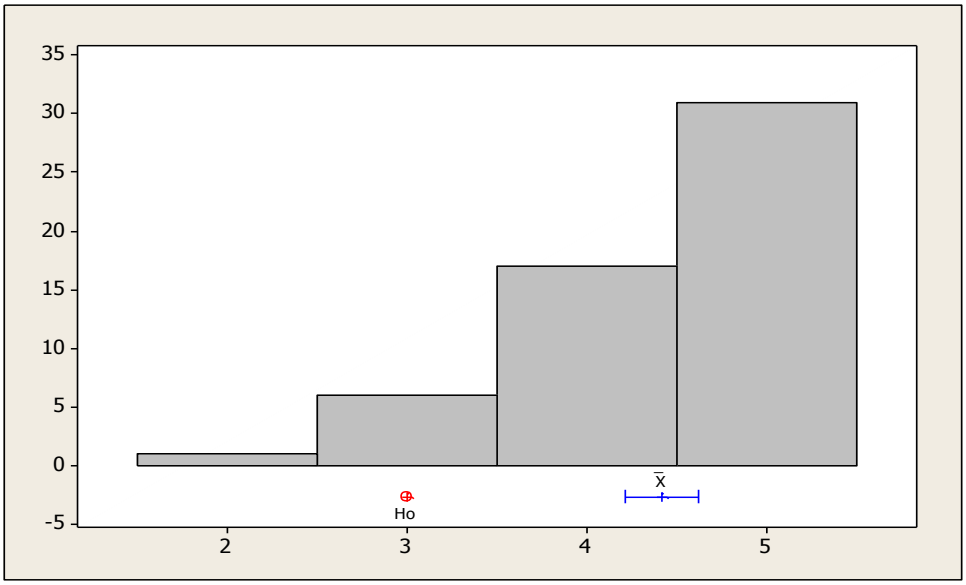

Figure 26. Histogram of responses to statement R10: Rated level of security/safety over Wi-Fi networks when emailing

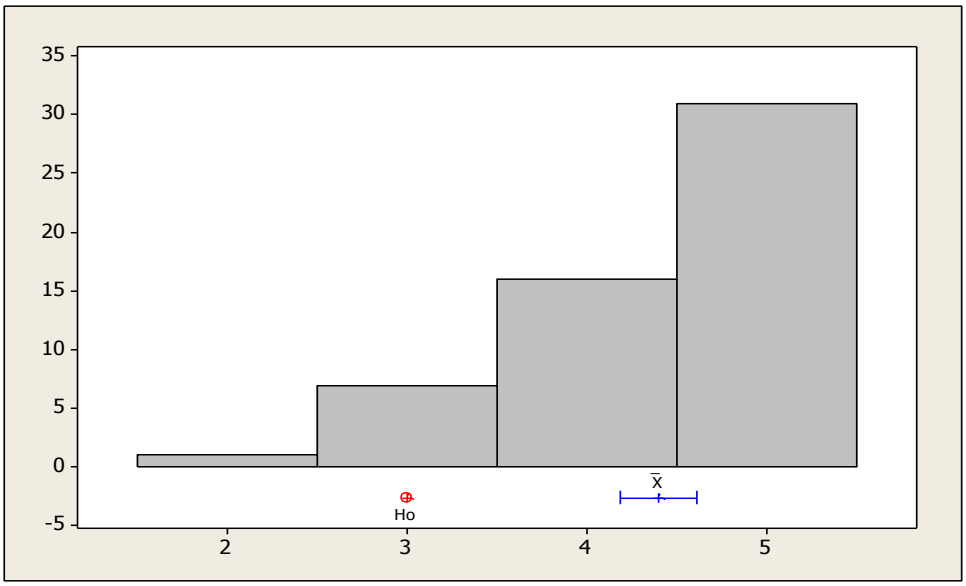

Figure 27. Histogram of responses to statement R11: Rated level of security/safety over Wi-Fi networks when web browsing

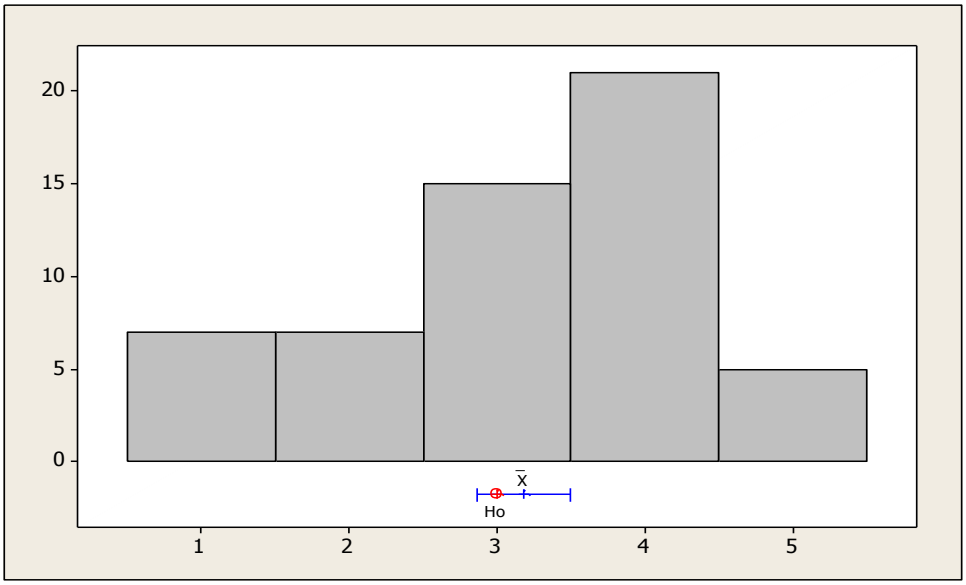

Figure 28. Histogram of responses to statement R12: Rated level of security/safety over Wi-Fi networks when mobile banking

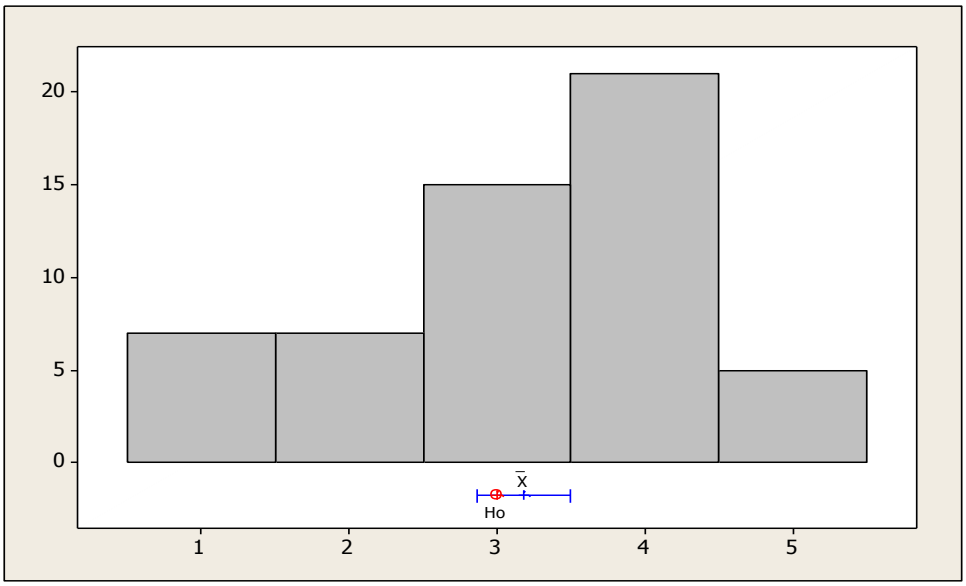

Figure 29. Histogram of responses to statement R13: Rated level of security/safety over Wi-Fi networks when buying/selling/trading stock

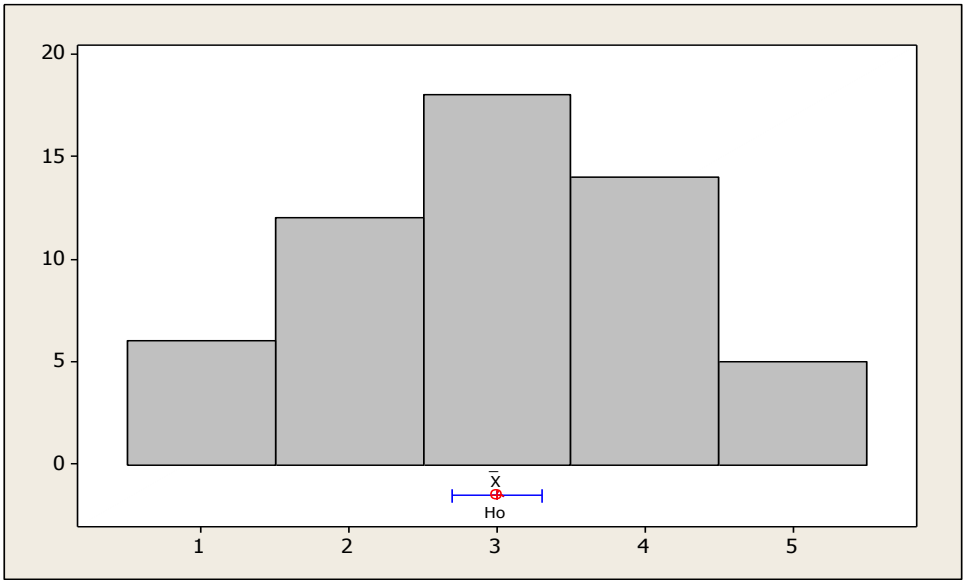

Figure 30. Histogram of responses to statement R14: Rated level of security/safety over Wi-Fi networks when making online purchases (E-Commerce)

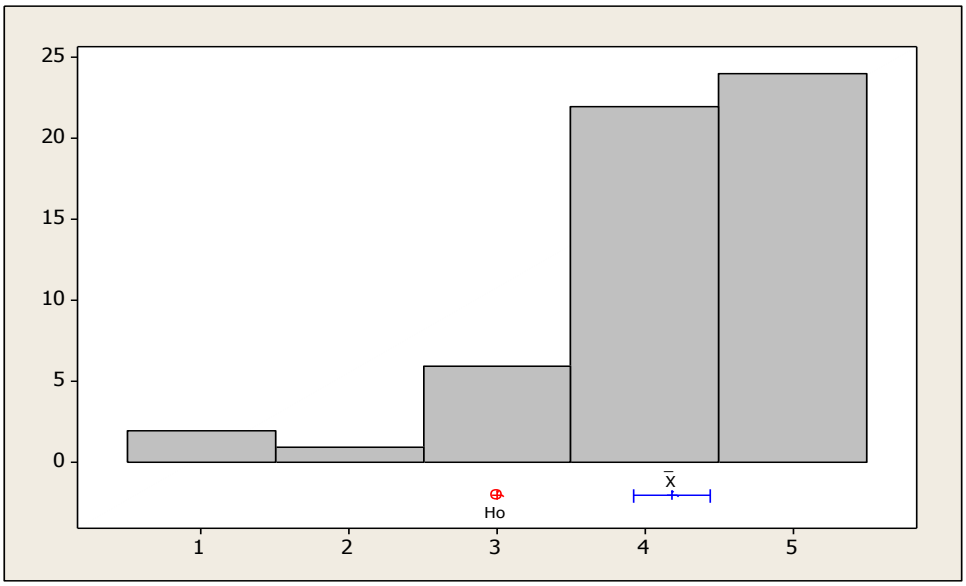

Figure 31. Histogram of responses to statement R15: Rated level of security/safety over Wi-Fi networks when using social networking sites

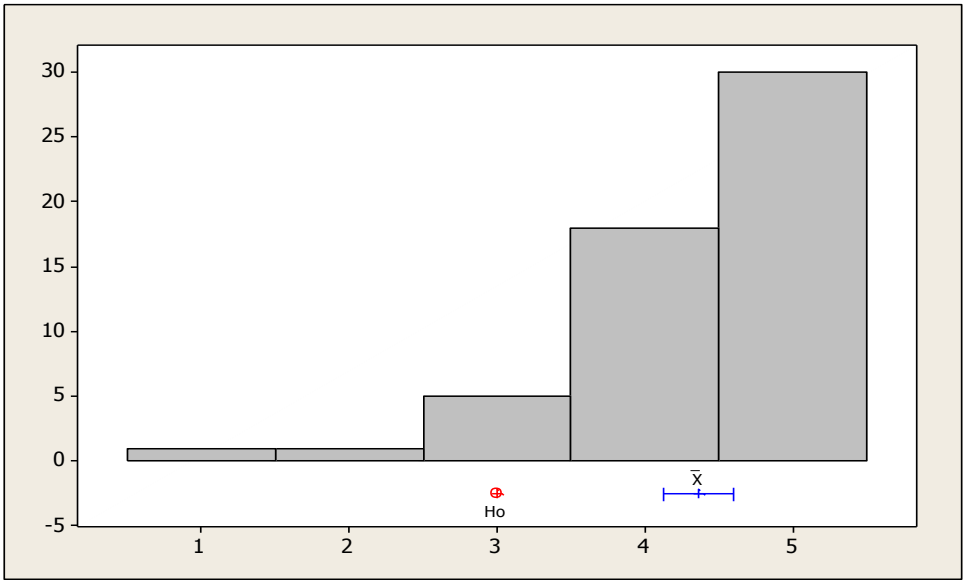

Figure 32. Histogram of responses to statement R16: Rated level of security/safety over Wi-Fi networks when using mobile applications (apps)

Visual analysis of the histogram distributions confirms the statistical analysis. Statements R4, R12, R13, and R14 have distributions that have near even results on either side of the neutral value of three. However, it is worth noting that statement R4 noticed more "disagree" results than "agree" results. Statements R12, R13, and R14 noticed more "agree" results, but these statements did not have many "strongly disagree" results. Statements R1, R2, R3, R7, R8, R9,

R10, R11, R15, and R16 all have distributions that are skewed to the agreement side of the scale (greater than three). Statements R5 and R6 Statements have distributions that are skewed to the disagreement side of the scale (less than three).

Statement U1 details the frequency at which users perform specific actions using their smartphones.

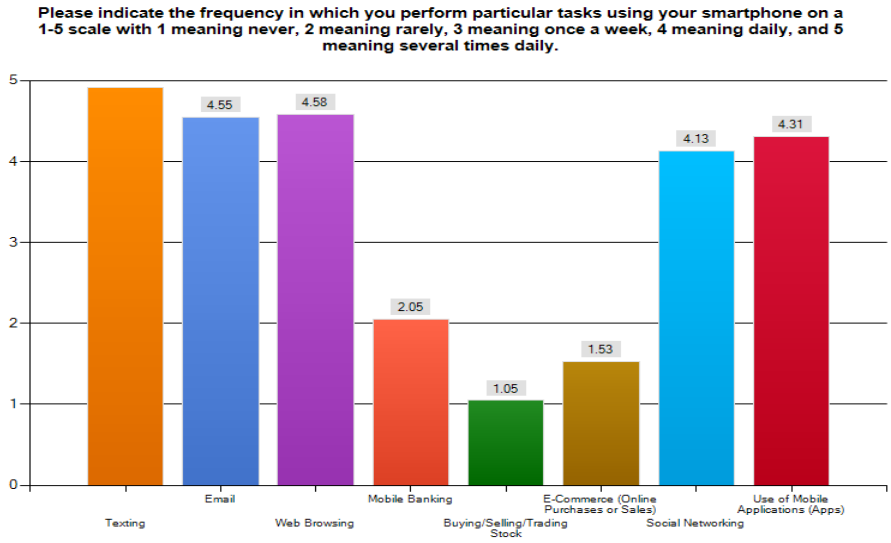

Figure 33. Bar Chart of responses to statement U1: Please indicate the frequency in which you perform particular tasks using your smartphone

Visual analysis of the results shows that texting, emailing, web browsing, and the use of both social networking sites and mobile applications are daily actions that are often noticed multiple times in any given day. Mobile banking is rarely noticed in the participants. Making online purchases is even less common, and there is only a single user that reported moving stock on a smartphone.

Statements D1 and D2 detail the specific reasons the participants gave, if any, for choosing to use a particular network when connecting to the internet from their smartphone.

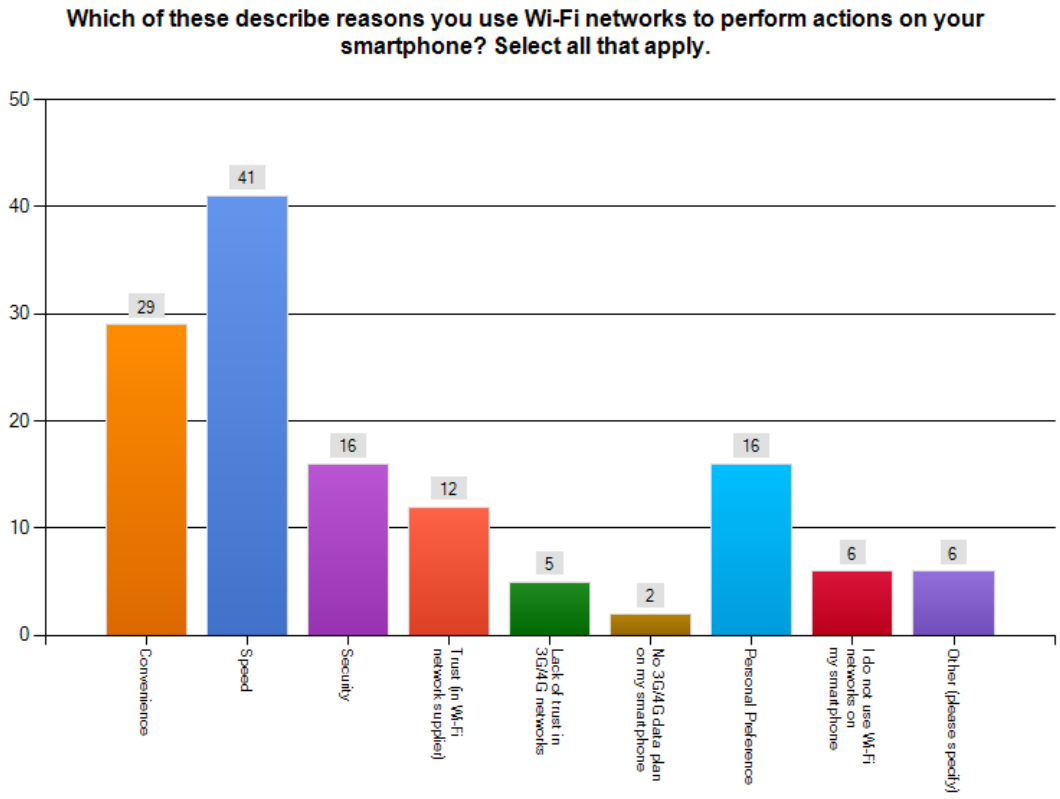

Figure 34. Bar Chart of responses to statement D1: Reasons for using Wi-Fi networks

Visual analysis of the results shows that the participants largely choose Wi-Fi networks for speed, convenience, security, personal preference, and trust in the network. Speed was the most frequent response, and the next common reason was convenience.

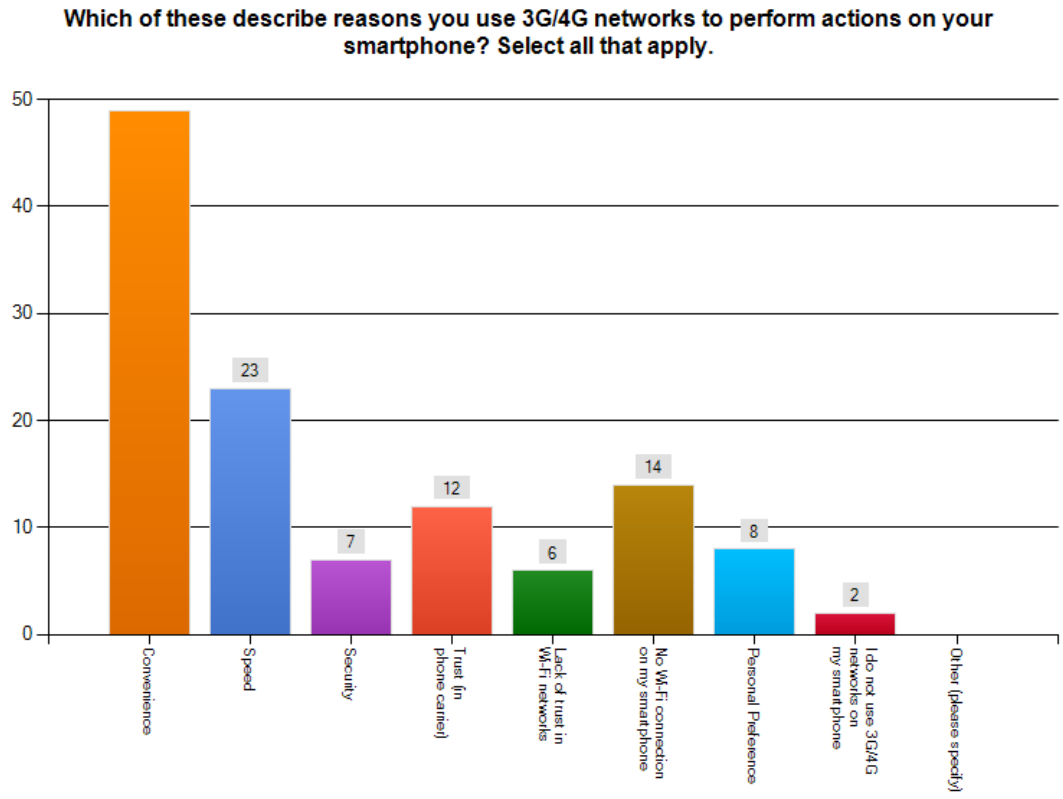

Figure 35. Bar Chart of responses to statement D2: Reasons for using 3G/4G networks

Visual analysis of the results shows that the participants tend to choose 3G or 4G networks for convenience, speed, a lack of a Wi-Fi connection, and trust in the phone carrier. Convenience was the most frequent reason reported and it more than doubled the next closest response of speed.

For the purpose of analyzing groups of statements, four averages were created. Average-safety represents the average means of the responses to statements S1-S10, because these statements together give an overall rating regarding feelings of safety and security of users. Average-3G represents the average means of the responses to statements R1-R8, as these statements relate to users' ratings of security over 3G/4G networks while performing specific actions. Average-Wi-Fi represents the average means of the responses to statements R9-R16.

These statements relate to users' ratings of security over Wi-Fi networks while performing specific actions. The fourth average, Average-Use, is the average means of the responses to statement U1, which details the frequency at which users perform specific actions using their smartphones. These averages were used as an average for each of their respective areas for analysis against the factors of interest. Knowledge statements K1-K4 were also compared against the gender factor. Preference statements P1 and P2 were compared against each of the factors of interest.

Age Factor

The results of the survey were limited to participants within the age range of 18-24. For this reason, age cannot be reported as a factor, because there is only one grouping.

Gender Factor

The gender factor was statistically analyzed using a two sample t-test, where the null hypothesis was the means of both male and female are equal, and the alternate hypothesis was that the means of male and female were not equal. Analysis was conducted with a 95% confidence interval and a pooled standard deviation.

Table 3. Two Sample T-Test: average-safety versus Gender

```
Two-sample T for average- safety

Gender   N   Mean  StDev  SE Mean
1       35  3.441  0.588    0.099
2       20  3.521  0.733     0.16


Difference = mu (1) - mu (2)
Estimate for difference:  -0.081
95% CI for difference:  (-0.471, 0.310)
T-Test of difference = 0 (vs not =): T-Value = -0.42  P-Value =
0.677  DF = 33
```

Statistical analysis showed no statistically significant effect of gender on average safety ratings. The means for male and female (3.441 and 3.521 respectively) were similar and both genders had a mean that favored feeling safe (greater than three) when using their smartphone.

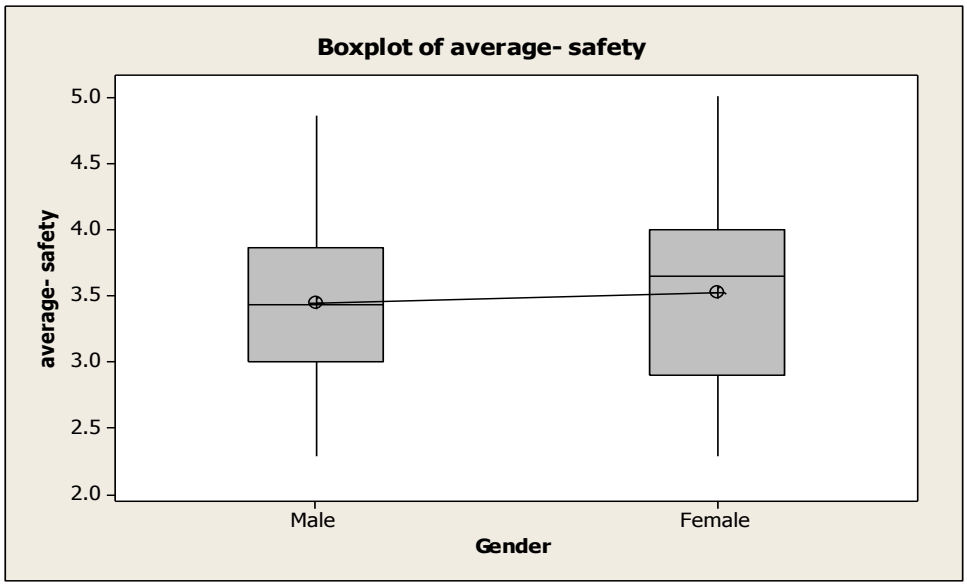

Figure 36. Boxplot of average-safety versus Gender

Figure 36 confirms the statistical analysis. There is little difference between the ranges and means of the genders when it comes to safety ratings.

Table 4. Two Sample T-Test: Average-Use versus Gender

```
Two-sample T for Average-Use

Gender   N   Mean  StDev  SE Mean
1       35  3.371  0.386    0.065
2       20  3.419  0.479     0.11


Difference = mu (1) - mu (2)
Estimate for difference:  -0.047
95% CI for difference:  (-0.302, 0.208)
T-Test of difference = 0 (vs not =): T-Value = -0.38  P-Value =
0.708  DF = 33
```

Statistical analysis showed no statistically significant effect of gender on the average use of smartphones. The means for male and female (3.371 and 3.419 respectively) were similar and both genders had a mean (greater than three) that signified use of actions almost daily.

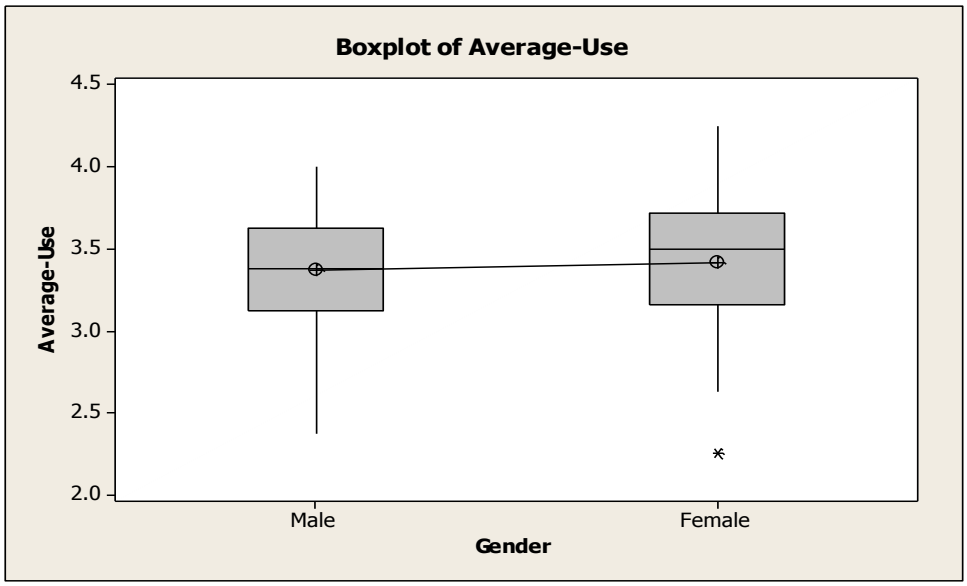

Figure 37. Boxplot of Average-Use versus Gender

Figure 37 confirms the statistical analysis. The means for both genders are very similar and the ranges of responses are also similar.

Table 5. Two Sample T-Test: average-3G versus Gender

```
Two-sample T for average-3G

Gender   N   Mean  StDev  SE Mean
1       35  3.671  0.524    0.089
2       20  3.763  0.834     0.19


Difference = mu (1) - mu (2)
Estimate for difference:  -0.091
95% CI for difference:  (-0.515, 0.333)
T-Test of difference = 0 (vs not =): T-Value = -0.44  P-Value =
0.663  DF = 27
```

Statistical analysis showed no statistically significant effect of gender on the average rating of safety on a 3G or 4G network. The means for male and female (3.671 and 3.763 respectively) both tended toward feeling secure when using a mobile network.

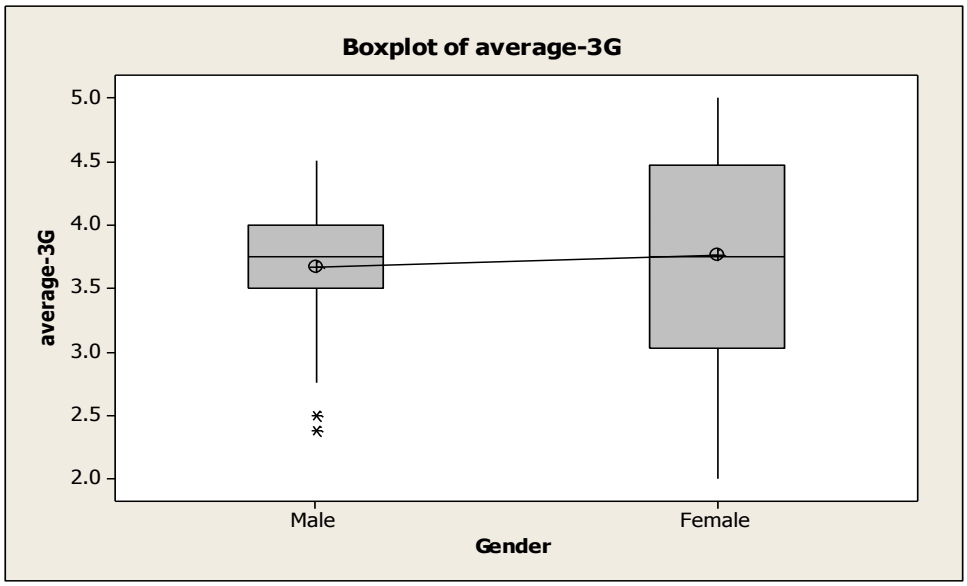

Figure 38. Boxplot of average-3G versus Gender

Figure 38 confirms the statistical analysis and offers insight. Males had a small range, and females had a wide range of results. Female responses included responses indicating both the most secure and the least secure feelings.

Table 6. Two Sample T-Test: average-Wi-Fi versus Gender

```
Two-sample T for average - Wi-Fi

Gender   N   Mean  StDev  SE Mean
1       35  3.836  0.706     0.12
2       20  3.856  0.695     0.16


Difference = mu (1) - mu (2)
Estimate for difference:  -0.021
95% CI for difference:  (-0.416, 0.375)
T-Test of difference = 0 (vs not =): T-Value = -0.10  P-Value =
0.917  DF = 40
```

Statistical analysis showed no statistically significant effect of gender on the average rating of safety on a Wi-Fi network. The means for male and female (3.836 and 3.856 respectively) were nearly identical and both tended toward feeling secure when using a Wi-Fi network.

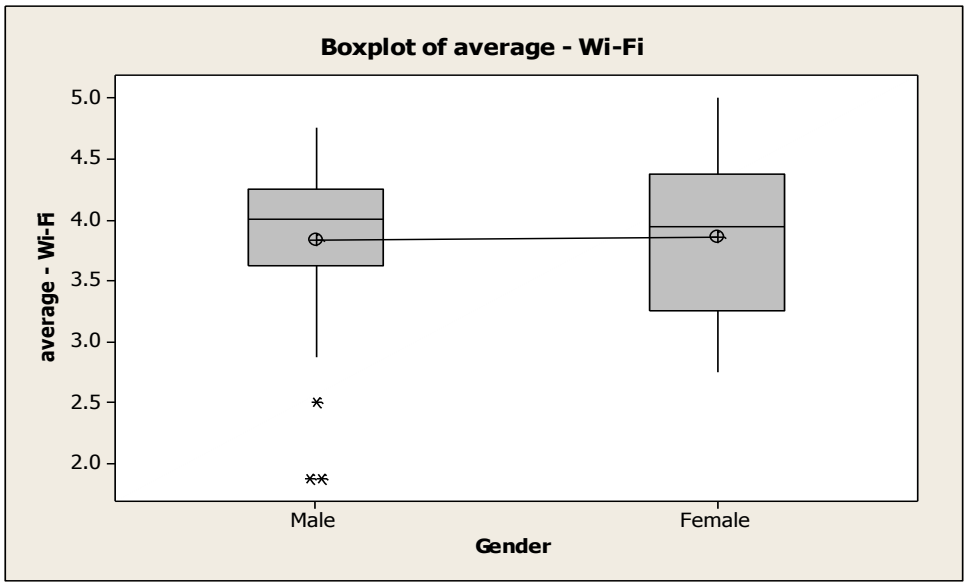

Figure 39. Boxplot of average-Wi-Fi versus Gender

Figure 39 confirms the statistical analysis. The means and ranges of responses for both genders are similar.

Table 7. Two Sample T-Test: Wi-Fi Understanding versus Gender

```
Two-sample T for Wi-Fi Understanding

Gender   N   Mean  StDev  SE Mean
1       35  2.429  0.655     0.11
2       20  1.950  0.605     0.14


Difference = mu (1) - mu (2)
Estimate for difference:  0.479
95% CI for difference:  (0.126, 0.831)
T-Test of difference = 0 (vs not =): T-Value = 2.74  P-Value =
0.009  DF = 42
```

Statistical analysis showed there was a statistically significant effect of gender on the average understanding of Wi-Fi networks. The means for male and female (2.429 and 1.950 respectively) were different.

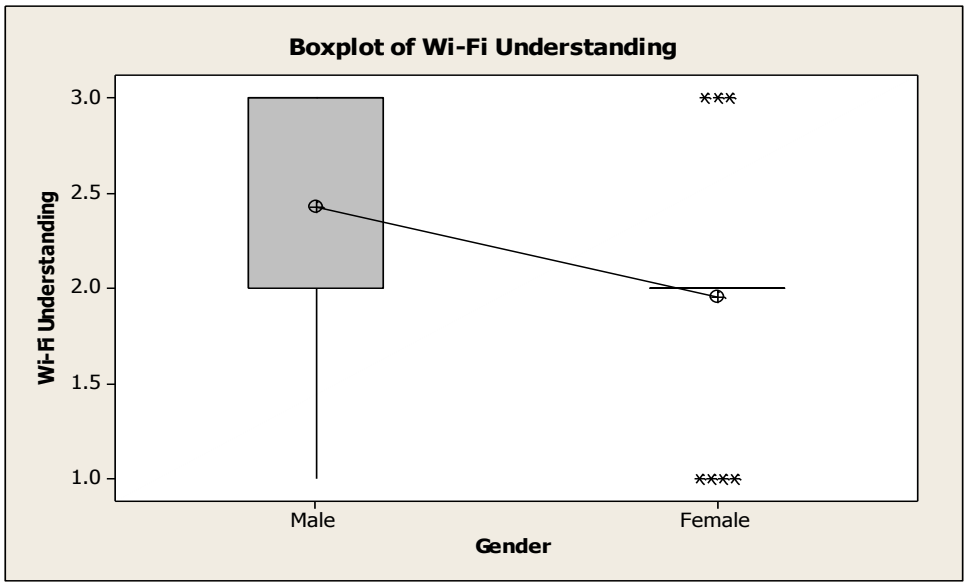

Figure 40. Boxplot of Wi-Fi Understanding versus Gender

Figure 40 confirms the statistical analysis. Gender means were significantly different, with male knowledge ratings being greater than female knowledge ratings.

Table 8. Two Sample T-Test: 3G/4G Understanding versus Gender

```
Two-sample T for 3G/4G Understanding

Gender   N   Mean  StDev  SE Mean
1       35  1.886  0.631     0.11
2       20  1.600  0.598     0.13


Difference = mu (1) - mu (2)
Estimate for difference:  0.286
95% CI for difference:  (-0.060, 0.631)
T-Test of difference = 0 (vs not =): T-Value = 1.67  P-Value =
0.103  DF = 41
```

Statistical analysis showed no statistically significant effect of gender on the average understanding of 3G/4G networks. The means for male and female (1.886 and 1.600 respectively) were nearly identical and both tended toward a low to moderate understanding of the networks. These results were noticeably lower than the understanding of Wi-Fi networks for both genders.

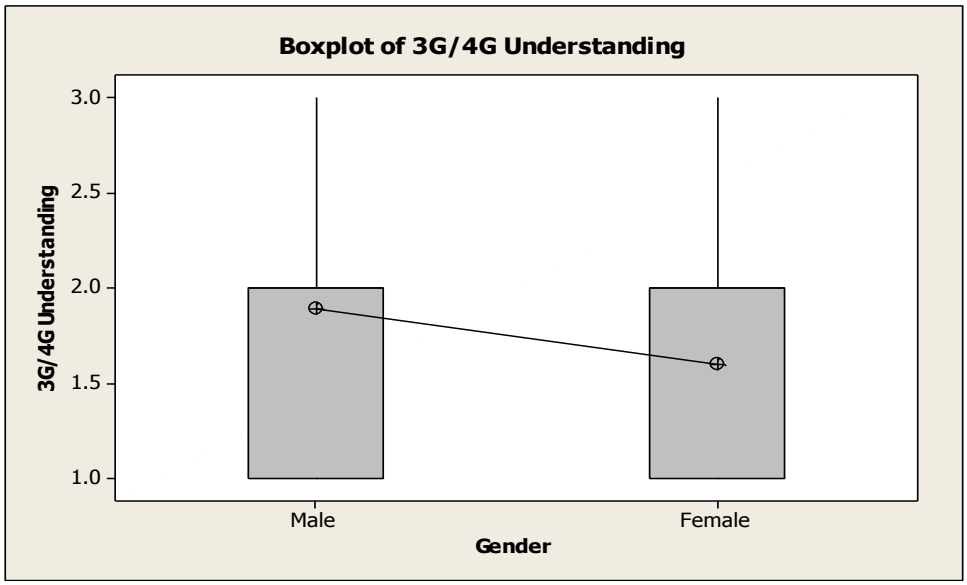

Figure 41. Boxplot of 3G/4G Understanding versus Gender

Figure 41 confirms the statistical analysis. The means were lower than the neutral value of two and were similar across gender.

Table 9. Two Sample T-Test: Technical Skill versus Gender

```
Two-sample T for Technical Skill

Gender   N   Mean  StDev  SE Mean
1       35  2.657  0.482    0.081
2       20  2.250  0.444    0.099


Difference = mu (1) - mu (2)
Estimate for difference:  0.407
95% CI for difference:  (0.148, 0.666)
T-Test of difference = 0 (vs not =): T-Value = 3.17  P-Value =
0.003  DF = 42
```

Statistical analysis showed there was a statistically significant effect of gender on average technical skill. The means for male and female (2.657 and 2.250 respectively) were different. Both genders rated themselves as having better than moderate technical skill.

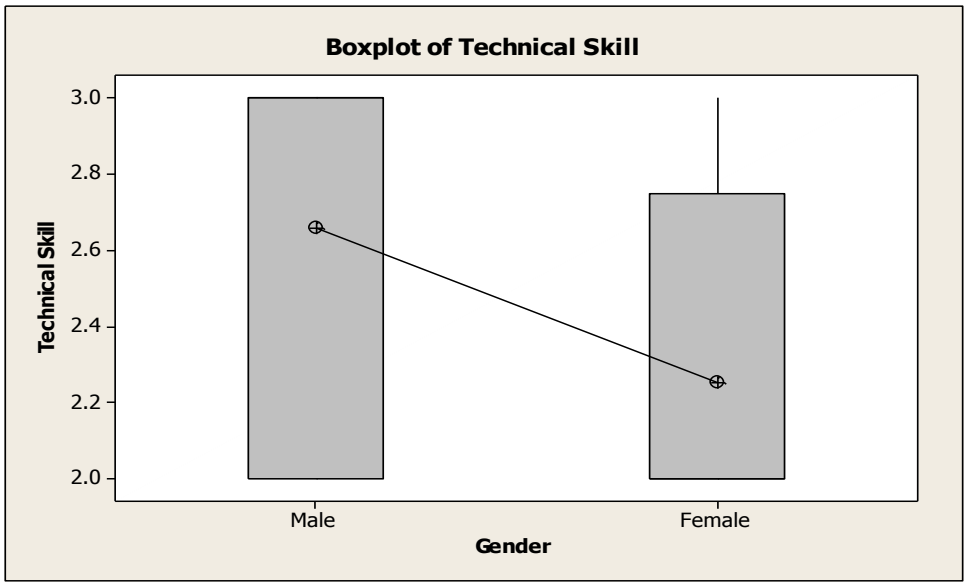

Figure 42. Boxplot of Technical Skill versus Gender

Figure 42 confirms the statistical analysis. The mean technical skill was greater for males than females, though both genders were around the neutral value of two.

Table 10. Two Sample T-Test: 3G/4G networks are more secure versus Gender

```
Two-sample T for 3G/4G networks are more secure

Gender   N   Mean  StDev  SE Mean
1       35  3.114  0.832     0.14
2       20  3.150  0.933     0.21


Difference = mu (1) - mu (2)
Estimate for difference:  -0.036
95% CI for difference:  (-0.546, 0.475)
T-Test of difference = 0 (vs not =): T-Value = -0.14  P-Value =
0.888  DF = 36
```

Statistical analysis showed no statistically significant effect of gender on the belief that 3G/4G networks are more secure than Wi-Fi networks. The means for male and female (3.114 and 3.150 respectively) were nearly identical and both tended toward a neutral response.

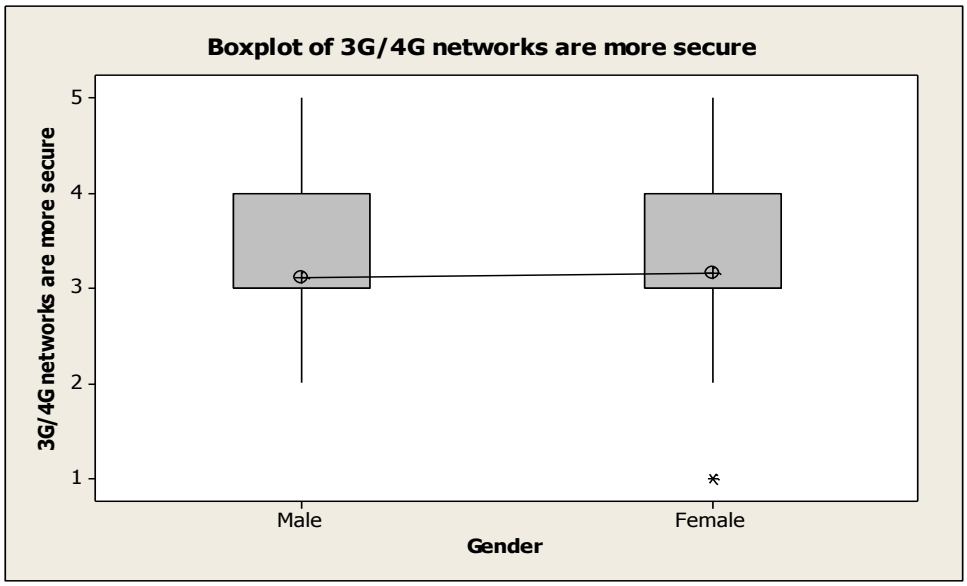

Figure 43. Boxplot of 3G/4G networks are more secure versus Gender

Figure 43 confirms the statistical analysis. Means for both males and females were comparable and tended toward neutral values of three.

Table 11. Two Sample T-Test: 3G/4G networks are more convenient versus Gender

```
Two-sample T for 3G/4G networks are more convenient

Gender   N   Mean  StDev  SE Mean
1       35   3.46   1.34     0.23
2       20  3.900  0.912     0.20


Difference = mu (1) - mu (2)
Estimate for difference:  -0.443
95% CI for difference:  (-1.054, 0.168)
T-Test of difference = 0 (vs not =): T-Value = -1.46  P-Value =
0.152  DF = 51
```

Statistical analysis showed no statistically significant effect of gender on the belief that 3G/4G networks are more convenient than Wi-Fi networks. The means for male and female (3.46 and 3.900 respectively) were similar and both tended toward a response of "agree".

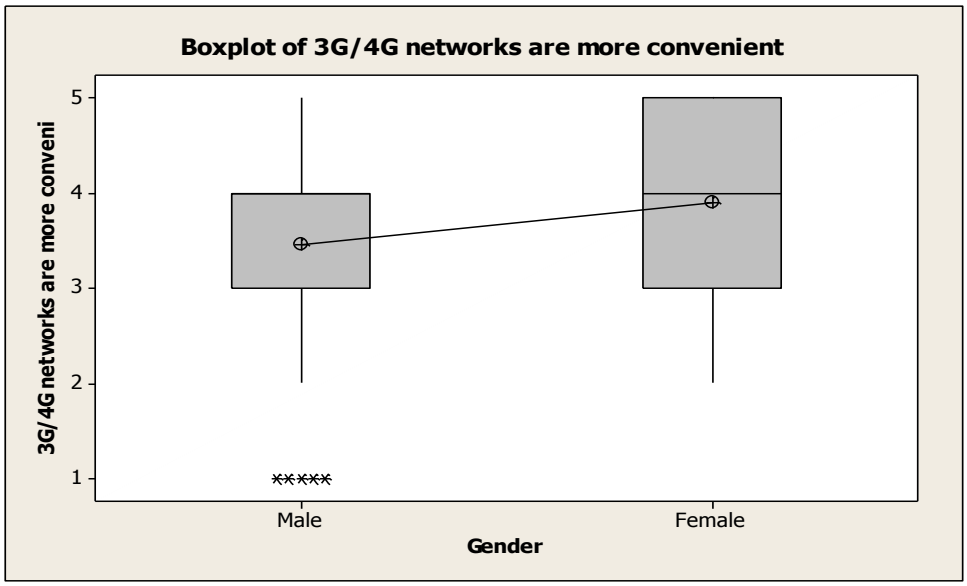

Figure 44. Boxplot of 3G/4G networks are more convenient versus Gender

Figure 44 confirms the statistical analysis. Means for both males and females were similar and tended toward a response of agreement.

Table 12. Two Sample T-Test: I prefer using Wi-Fi networks versus Gender

```
Two-sample T for I prefer using Wi-Fi networks

Gender   N  Mean  StDev  SE Mean
1       35  3.14   1.24     0.21
2       20  3.00   1.34     0.30


Difference = mu (1) - mu (2)
Estimate for difference:  0.143
95% CI for difference:  (-0.597, 0.883)
T-Test of difference = 0 (vs not =): T-Value = 0.39  P-Value =
0.698  DF = 37
```

Statistical analysis showed no statistically significant effect of gender on the preference of using Wi-Fi networks over using 3G/4G networks. The means for male and female (3.14 and 3.000 respectively) were nearly identical and both tended toward a neutral response.

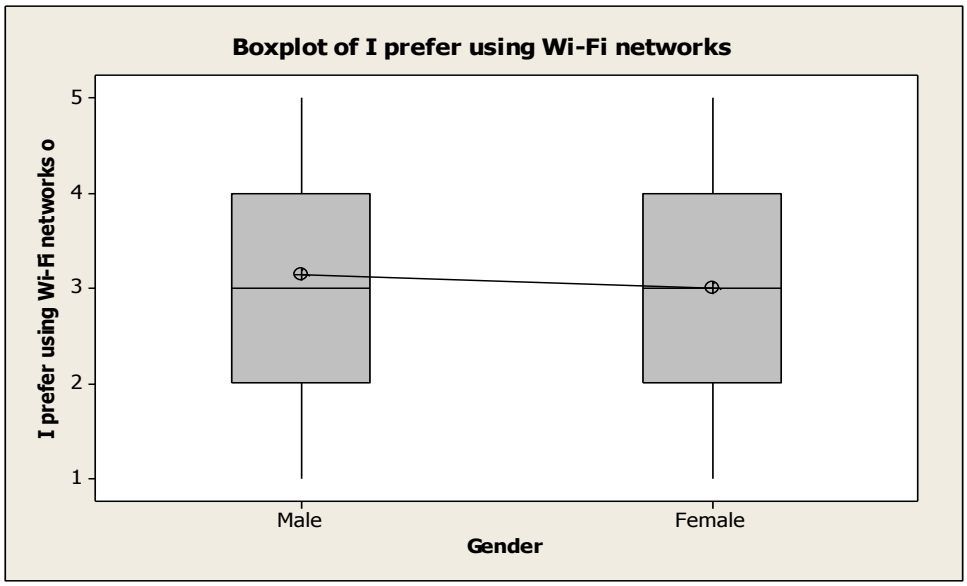

Figure 45. Boxplot of I prefer using Wi-Fi networks versus Gender

Figure 45 confirms the statistical analysis. Gender did not affect the participants' preference of networks.

Technical Skill Factor

The technical skill factor was statistically analyzed using a two sample t-test, where the null hypothesis was that the means of both moderate and high technical skill were equal, and the alternate hypothesis was that the means of moderate and high technical skill were not equal. Analysis was conducted with a 95% confidence interval and a pooled standard deviation.

Table 13. Two Sample T-Test: average-safety versus Technical Skill

```
Two-sample T for average- safety

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.503  0.701     0.13
3          28  3.439  0.584     0.11


Difference = mu (2) - mu (3)
Estimate for difference:  0.064
95% CI for difference:  (-0.286, 0.414)
T-Test of difference = 0 (vs not =): T-Value = 0.37  P-Value =
0.716  DF = 50
```

Statistical analysis showed no statistically significant effect of technical skill on average safety ratings. The means for moderate and high technical skill (3.503 and 3.439 respectively) were similar and both levels of technical skill had a mean that favored feeling safe (greater than three) when using their smartphone.

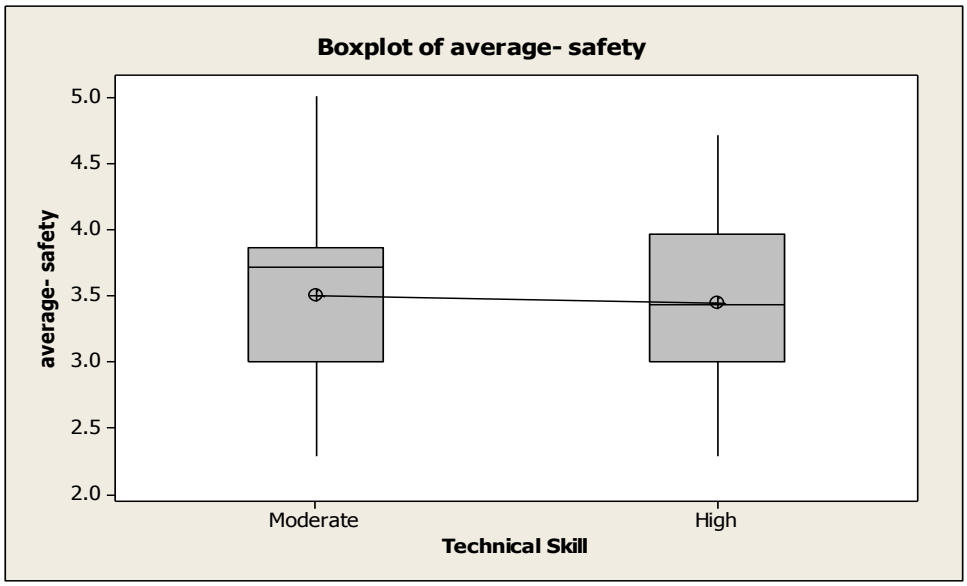

Figure 46. Boxplot of average-safety versus Technical Skill

Figure 46 confirms the statistical analysis and offers insight. Highly technical participants had a more concentrated range, and participants with moderate technical skill had a wide range of results that included some participants feeling very safe.

Table 14. Two Sample T-Test: Average-Use versus Technical Skill

```
Two-sample T for Average-Use

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.384  0.433    0.083
3          28  3.393  0.412    0.078


Difference = mu (2) - mu (3)
Estimate for difference:  -0.009
95% CI for difference:  (-0.237, 0.220)
T-Test of difference = 0 (vs not =): T-Value = -0.08  P-Value =
0.940  DF = 52
```

Statistical analysis showed no statistically significant effect of technical skill on the average use of smartphones. The means for moderate and high technical skill (3.384 and 3.393 respectively) were similar and both levels of technical skill had a mean (greater than three) that signified use of most actions at least once a day.

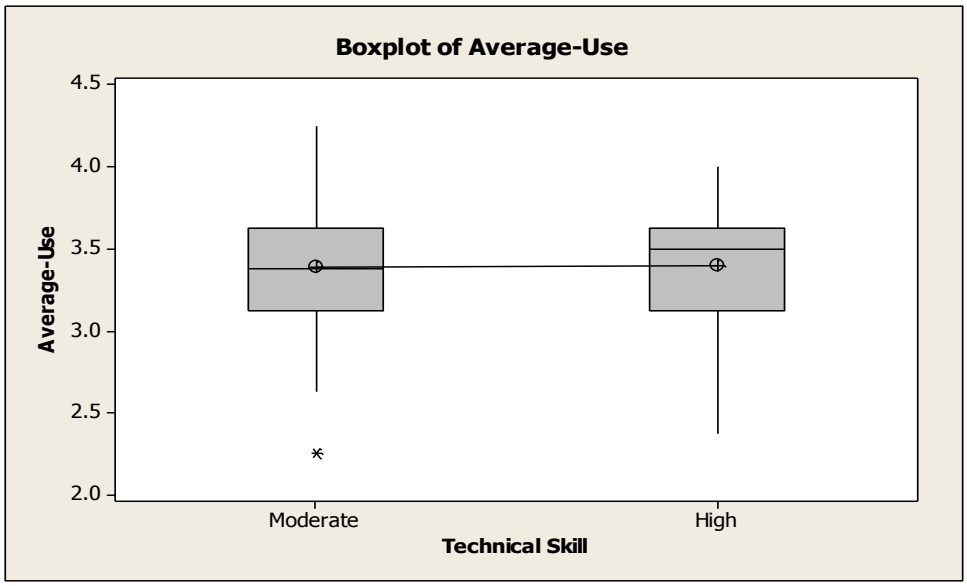

Figure 47. Boxplot of Average-Use versus Technical Skill

Figure 47 confirms the statistical analysis. Technical skill had no real effect on the average use of smartphones.

Table 15. Two Sample T-Test: average-3G versus Technical Skill

```
Two-sample T for average-3G

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.713  0.600     0.12
3          28  3.696  0.702     0.13


Difference = mu (2) - mu (3)
Estimate for difference:  0.017
95% CI for difference:  (-0.336, 0.369)
T-Test of difference = 0 (vs not =): T-Value = 0.09  P-Value =
0.925  DF = 52
```

Statistical analysis showed no statistically significant effect of technical skill on average safety rating on a 3G or 4G network. The means for moderate and high technical skill (3.713 and 3.696 respectively) were similar and both levels of technical skill had a mean that signified feeling secure on a mobile network.

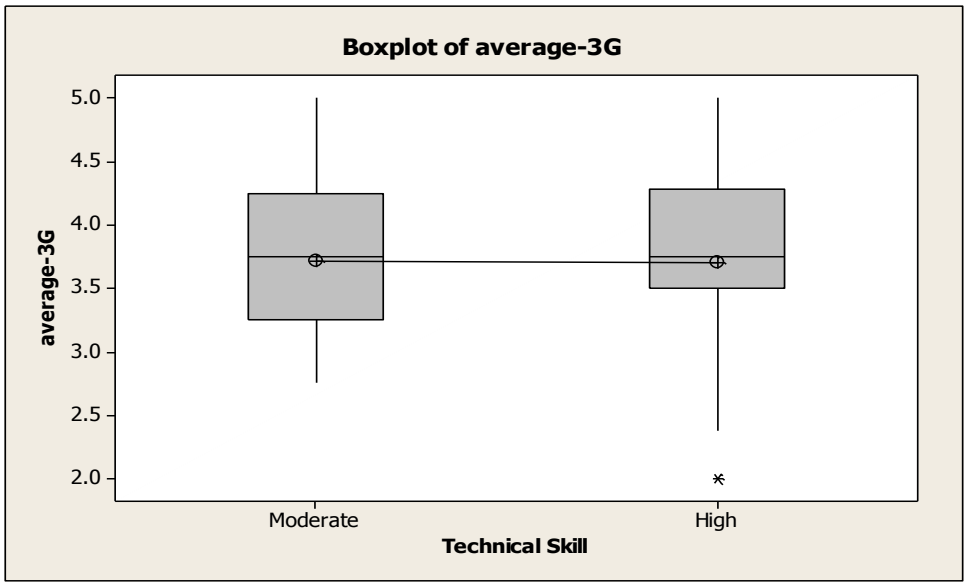

Figure 48. Boxplot of average-3G versus Technical Skill

Figure 48 confirms the statistical analysis and offers insight. Highly technical participants varied greatly in their responses with some feeling very safe on a mobile network and some feeling unsafe.

Table 16. Two Sample T-Test: average-Wi-Fi versus Technical Skill

```
Two-sample T for average - Wi-Fi

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.824  0.563     0.11
3          28  3.862  0.813     0.15


Difference = mu (2) - mu (3)
Estimate for difference:  -0.038
95% CI for difference:  (-0.415, 0.340)
T-Test of difference = 0 (vs not =): T-Value = -0.20  P-Value =
0.843  DF = 48
```

Statistical analysis showed no statistically significant effect of technical skill on average safety rating on a Wi-Fi network. The means for moderate and high technical skill (3.824 and 3.862 respectively) were similar and both levels of technical skill had a mean that signified feeling secure on a Wi-Fi network.

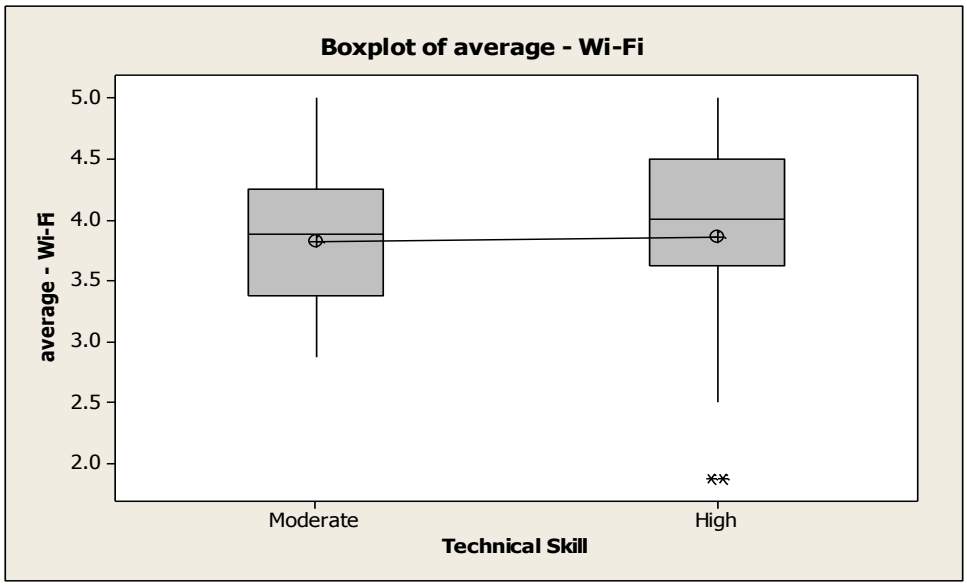

Figure 49. Boxplot of average-Wi-Fi versus Technical Skill

Figure 49 confirms the statistical analysis and offers insight. Highly technical participants varied greatly in their responses with some feeling very safe on a Wi-Fi network and some feeling unsafe.

Table 17. Two Sample T-Test: 3G/4G networks are more convenient versus Technical Skill

```
Two-sample T for 3G/4G networks are more convenient

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.963  0.808     0.16
3          28   3.29   1.44     0.27


Difference = mu (2) - mu (3)
Estimate for difference:  0.677
95% CI for difference:  (0.046, 1.309)
T-Test of difference = 0 (vs not =): T-Value = 2.16  P-Value =
0.036  DF = 42
```

Statistical analysis showed there was a statistically significant effect of technical skill on the feeling that 3G/4G networks are more convenient than Wi-Fi networks. The means for male and female (3.963 and 3.29 respectively) were different. Both genders believed that 3G/4G networks were more convenient than Wi-Fi networks.

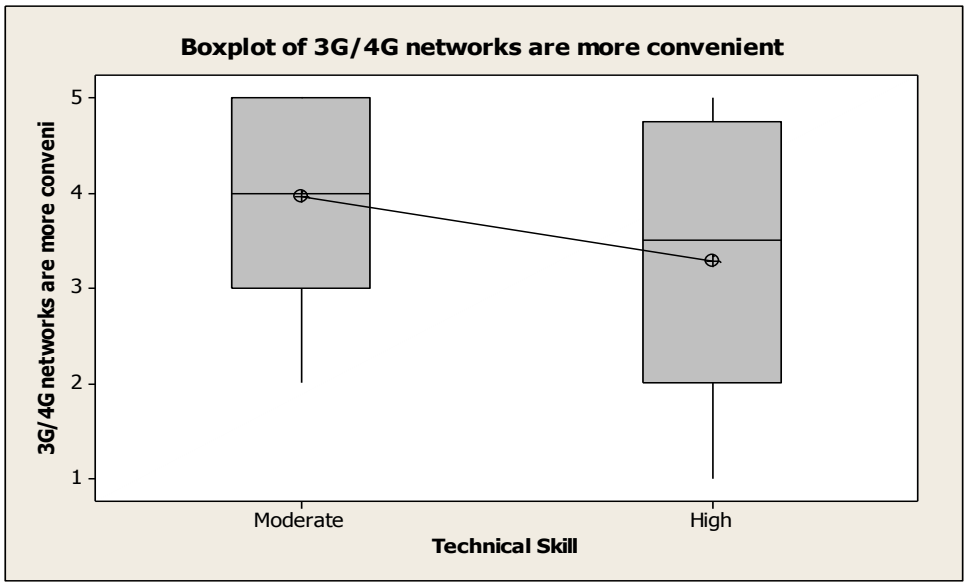

Figure 50. Boxplot of 3G/4G networks are more convenient versus Technical Skill

Figure 50 confirms the statistical analysis. The mean for male responses was higher than female responses, but both genders did agree with the statement.

Table 18. Two Sample T-Test: I prefer using Wi-Fi networks versus Technical Skill

```
Two-sample T for I prefer using Wi-Fi networks

Technical
Skill       N  Mean  StDev  SE Mean
2          27  2.96   1.26     0.24
3          28  3.21   1.29     0.24


Difference = mu (2) - mu (3)
Estimate for difference:  -0.251
95% CI for difference:  (-0.939, 0.437)
T-Test of difference = 0 (vs not =): T-Value = -0.73  P-Value =
0.467  DF = 52
```

Statistical analysis showed no statistically significant effect of technical skill on preference of Wi-Fi networks over 3G/4G networks. The means for moderate and high technical skill (2.96 and 3.21 respectively) were similar and both levels of technical skill had a mean response that tended toward the neutral value of three.

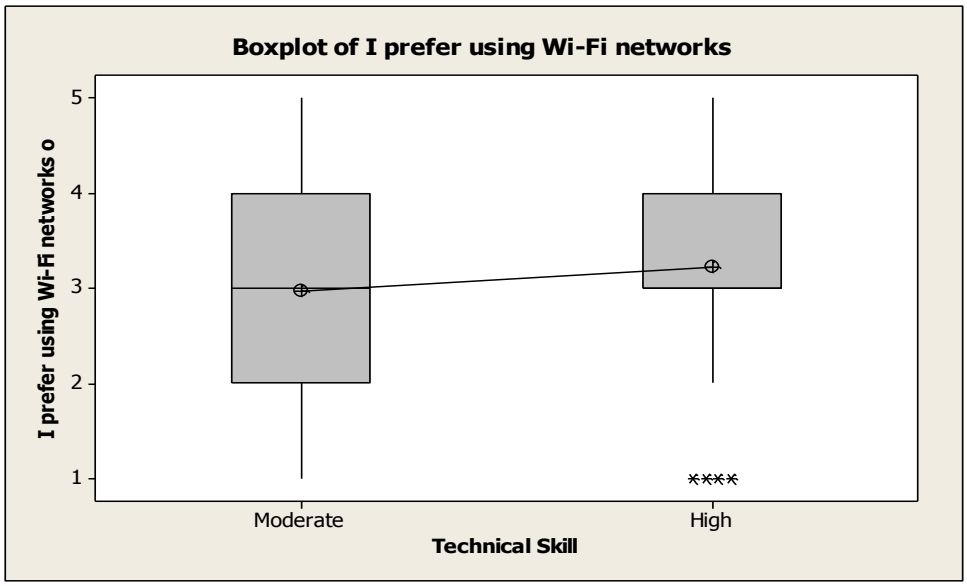

Figure 51. Boxplot of I prefer using Wi-Fi networks versus Technical Skill

Figure 51 confirms the statistical analysis. Means for both levels of technical skill were similar and near to three.

Understanding of Wi-Fi Factor

The understanding of Wi-Fi factor was statistically analyzed using a one-way ANOVA test, where the null hypothesis was that the means of low, moderate and high understanding of Wi-Fi were all equal. The alternate hypothesis was that at least one of the means was not equal. Analysis was conducted with a 95% confidence interval and a pooled standard deviation.

Table 19. One-Way ANOVA: average-safety versus Wi-Fi Understanding

```
Source                DF      SS     MS     F      P
Wi-Fi Understanding    2   0.606  0.303  0.73  0.485
Error                 52  21.462  0.413
Total                 54  22.068

S = 0.6424   R-Sq = 2.75%   R-Sq(adj) = 0.00%


                            Individual 95% CIs For Mean Based on
Pooled StDev
Level   N    Mean   StDev    +---------+---------+---------+----
-----
1       7  3.4898  0.7278    (-------------------*--------------
----)
2      27  3.5661  0.6246                  (---------*---------)
3      21  3.3401  0.6380      (-----------*----------)
                             +---------+---------+---------+----
-----
                           3.00      3.25      3.50      3.75

Pooled StDev = 0.6424
```

Statistical analysis showed no statistically significant effect of participants' understanding of Wi-Fi networks on average safety ratings. The means for low, moderate and high understanding (3.4898, 3.5661, and 3.3401 respectively) were similar and all levels of understanding had a mean that favored feeling safe (greater than three) when using their smartphone.

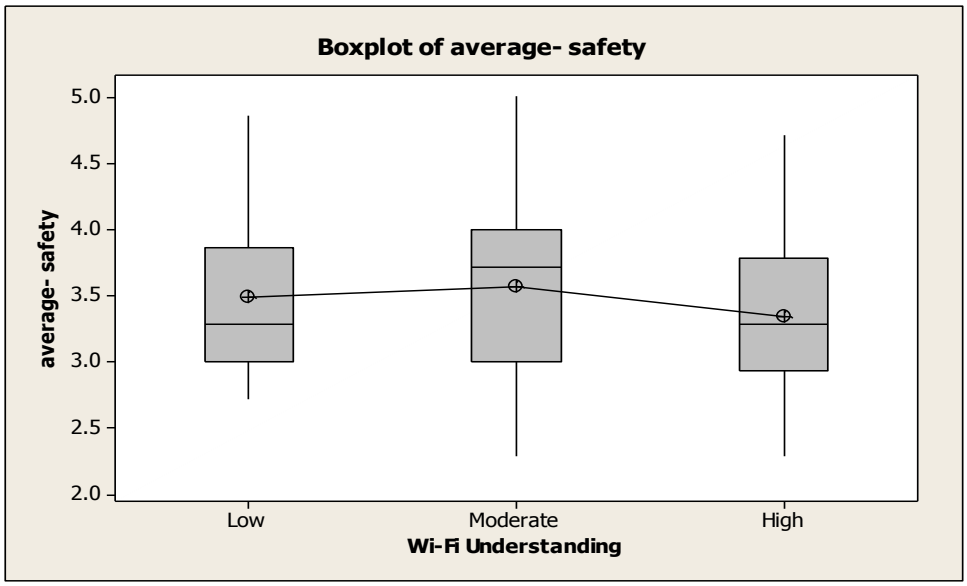

Figure 52. Boxplot of average-safety versus Wi-Fi Understanding

Figure 52 confirms the statistical analysis. The means and ranges of responses for each group are similar.

Table 20. One-Way ANOVA: Average-Use versus Wi-Fi Understanding

```
Source                DF     SS     MS     F      P
Wi-Fi Understanding    2  1.228  0.614  3.88  0.027
Error                 52  8.230  0.158
Total                 54  9.459

S = 0.3978   R-Sq = 12.99%   R-Sq(adj) = 9.64%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level    N    Mean   StDev  --------+---------+---------+---------+-
1        7  3.0893  0.4661  (-----------*-----------)
2       27  3.5231  0.3502                      (-----*-----)
3       21  3.3155  0.4323            (------*------)
                          --------+---------+---------+---------+-
                                3.00      3.25      3.50      3.75

Pooled StDev = 0.3978
```

Statistical analysis showed a statistically significant effect of participants' understanding of Wi-Fi networks on the participants' average use ratings. The low understanding group had a significantly different mean (3.0893) than the moderate understanding (3.5231). Participants

with high understand had a mean of 3.3155. The sample size for the low understanding was very small, so the results cannot be given weight.

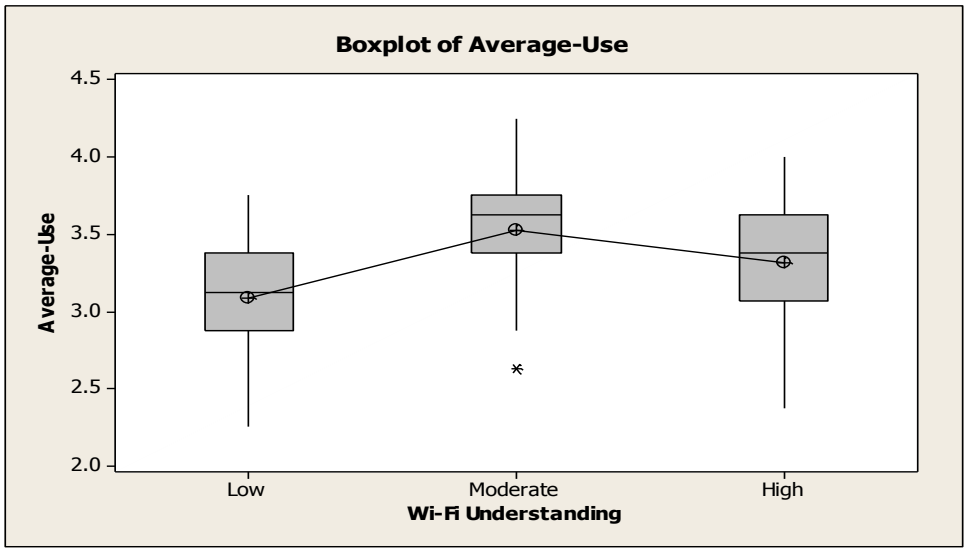

Figure 53. Boxplot of Average-Use versus Wi-Fi Understanding

Figure 53 confirms the statistical analysis. Participants with a low understanding of Wi-Fi networks tended to perform actions less frequently on their smartphone than participants with a higher understanding of Wi-Fi networks.

Table 21. One-Way ANOVA: average-3G versus Wi-Fi Understanding

```
Source                DF      SS     MS     F      P
Wi-Fi Understanding    2   1.626  0.813  2.01  0.144
Error                 52  21.042  0.405
Total                 54  22.668

S = 0.6361   R-Sq = 7.17%   R-Sq(adj) = 3.60%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  --------+---------+---------+--------
-+-
1       7  3.5357  0.6280  (---------------*---------------)
2      27  3.8796  0.5939                    (-------*--------)
3      21  3.5357  0.6894         (--------*--------)
                           --------+---------+---------+--------
-+-
                                 3.30      3.60      3.90
4.20

Pooled StDev = 0.6361
```

Statistical analysis showed no statistically significant effect of participants' understanding of Wi-Fi networks on safety rating on a 3G or 4G network. The means for low, moderate and high understanding (3.5357, 3.8796, and 3.5357 respectively) were similar and all levels of understanding had a mean that favored feeling safe (greater than three) when utilizing a mobile network.

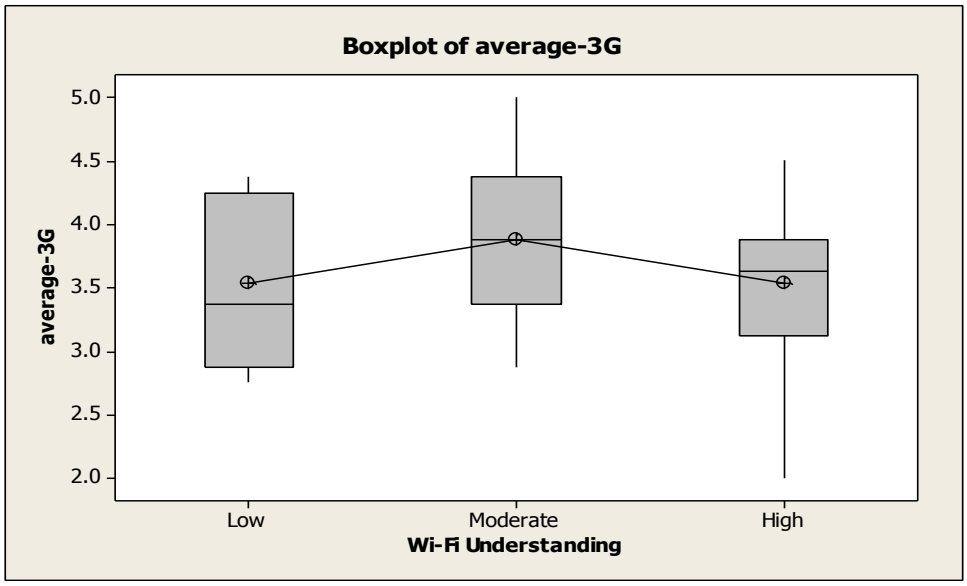

Figure 54. Boxplot of average-3G versus Wi-Fi Understanding

Figure 54 confirms the statistical analysis. Participants with a strong understanding of Wi-Fi networks had the greatest range of responses.

Table 22. One-Way ANOVA: average-Wi-Fi versus Wi-Fi Understanding

```
Source                DF      SS     MS     F      P
Wi-Fi Understanding    2   0.828  0.414  0.85  0.432
Error                 52  25.272  0.486
Total                 54  26.101

S = 0.6971   R-Sq = 3.17%   R-Sq(adj) = 0.00%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  ------+---------+---------+---------
+---
1       7  3.6429  0.5926  (----------------*-----------------)
2      27  3.9630  0.5324                   (--------*--------
)
3      21  3.7560  0.8887            (---------*---------)
```

```
                              ------+---------+---------+---------
+---
                                  3.30      3.60      3.90
4.20
Pooled StDev = 0.6971
```

Statistical analysis showed no statistically significant effect of participants' understanding of Wi-Fi networks on safety rating on a Wi-Fi network. The means for low, moderate and high understanding (3.6429, 3.9630, and 3.7560 respectively) were similar and all levels of understanding had a mean that favored feeling safe (greater than three) when utilizing a Wi-Fi network.

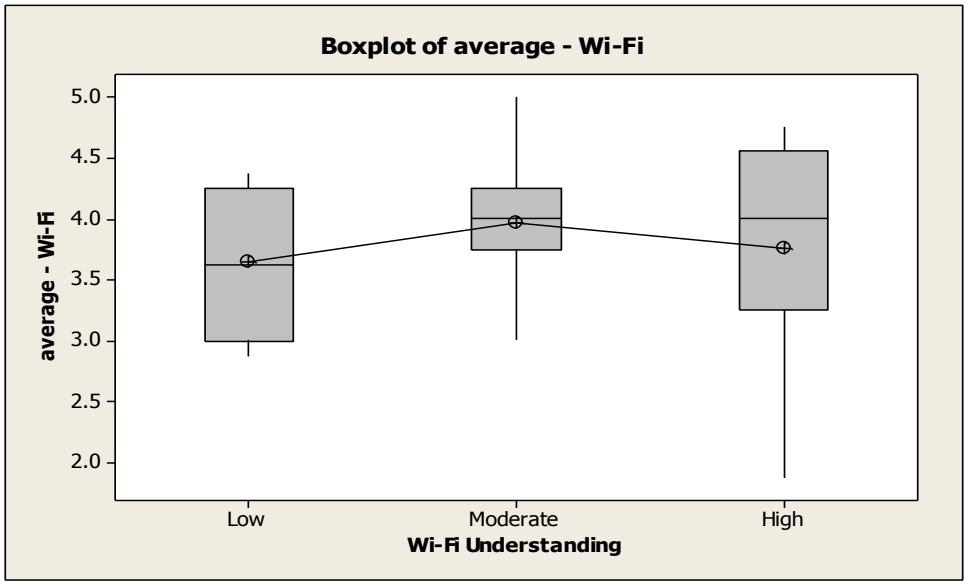

Figure 55. Boxplot of average-Wi-Fi versus Wi-Fi Understanding

Figure 55 confirms the statistical analysis. Participants with a strong understanding of Wi-Fi networks had the greatest range of responses.

Table 23. One-way ANOVA: 3G/4G networks are more convenient versus Wi-Fi Understanding

```
Source                DF     SS    MS     F      P
Wi-Fi Understanding    2   6.22  3.11  2.22  0.119
Error                 52  72.76  1.40
Total                 54  78.98

S = 1.183   R-Sq = 7.88%   R-Sq(adj) = 4.33%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N   Mean  StDev   -----+---------+---------+---------+---
-
1       7  3.857  0.900       (--------------*--------------)
2      27  3.889  1.121               (-------*------)
3      21  3.190  1.327   (--------*--------)
                          -----+---------+---------+---------+---
-
                             3.00      3.60      4.20      4.80

Pooled StDev = 1.183
```

Statistical analysis showed no statistically significant effect of participants' understanding of Wi-Fi networks on the belief that 3G/4G networks are more convenient than Wi-Fi networks. The means for low, moderate and high understanding (3.857, 3.889, and 3.190 respectively) were similar and all levels of understanding had a mean that favored 3G/4G networks for convenience.

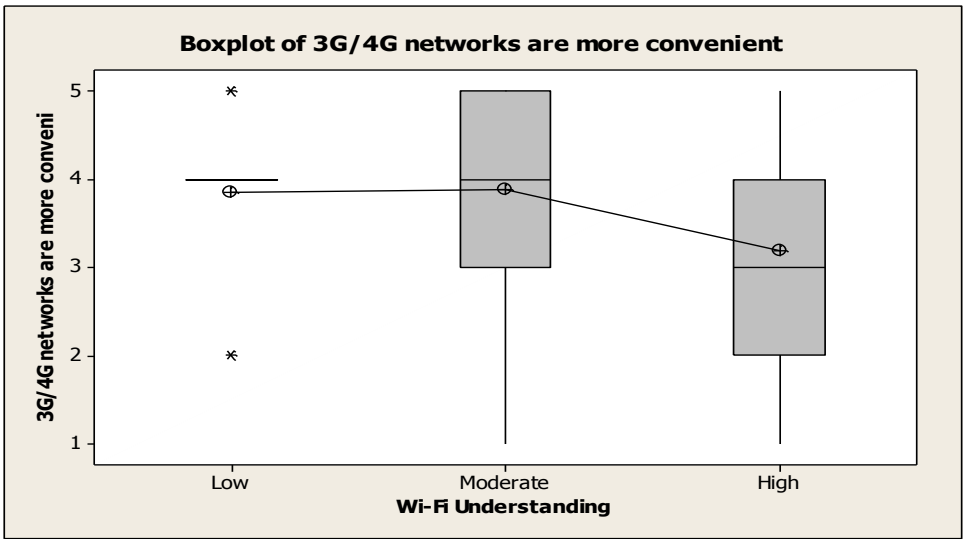

Figure 56. Boxplot of 3G/4G networks are more convenient

Figure 56 confirms the statistical analysis. The means are all greater than three and they are similar. It is worth noting that the participants with the highest rated understanding of Wi-Fi felt less strongly about 3G/4G networks being more convenient.

Table 24. One-way ANOVA: I prefer using Wi-Fi networks versus Wi-Fi Understanding

```
Source                DF     SS    MS     F      P
Wi-Fi Understanding    2  10.47  5.24  3.58  0.035
Error                 52  76.07  1.46
Total                 54  86.55

S = 1.210   R-Sq = 12.10%   R-Sq(adj) = 8.72%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N   Mean  StDev   --------+---------+---------+---------
+-
1       7  2.429  0.976   (------------*------------)
2      27  2.852  1.322              (------*-----)
3      21  3.619  1.117                       (-------*------)
                          --------+---------+---------+---------
+-
                                2.10      2.80      3.50
4.20

Pooled StDev = 1.210
```

Statistical analysis showed that there was a significant effect of participants' Wi-Fi understanding on the preference of Wi-Fi networks over 3G/4G networks. As the ratings of Wi-Fi understanding increase, the means for preferences increase as well.

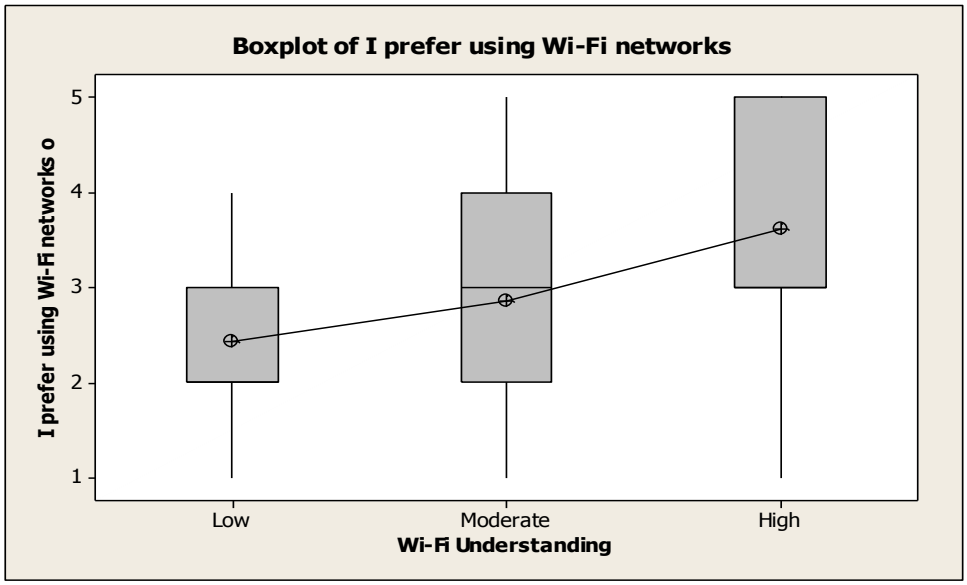

Figure 57. Boxplot of I prefer using Wi-Fi networks versus Wi-Fi Understanding

Figure 57 confirms the statistical analysis. The participants' preference for Wi-Fi networks increased as the level of understanding of Wi-Fi network increased.

Understanding of 3G/4G Factor

The understanding of 3G/4G factor was statistically analyzed using a one-way ANOVA test, where the null hypothesis was that the means of low, moderate and high understanding of 3G/4G were all equal. The alternate hypothesis was that at least one of the means was not equal. Analysis was conducted with a 95% confidence interval and a pooled standard deviation.

Table 25. One-Way ANOVA: average-safety versus 3G/4G Understanding

```
Source                DF      SS     MS     F      P
3G/4G Understanding    2   1.705  0.852  2.18  0.124
Error                 52  20.364  0.392
Total                 54  22.068

S = 0.6258   R-Sq = 7.72%   R-Sq(adj) = 4.18%


                            Individual 95% CIs For Mean Based on Pooled StDev
Level   N    Mean   StDev    +---------+---------+---------+---------
1      18  3.4841  0.7656                        (--------*-------)
2      31  3.5576  0.5311                            (------*-----)
3       6  2.9762  0.6222    (--------------*--------------)
                            +---------+---------+---------+---------
                           2.45      2.80      3.15      3.50

Pooled StDev = 0.6258
```

Statistical analysis showed no statistically significant effect of participants' understanding of 3G/4G networks on average safety ratings. The means for low, moderate and high understanding were similar and only the high understanding group did not feel safe when using their smartphone.

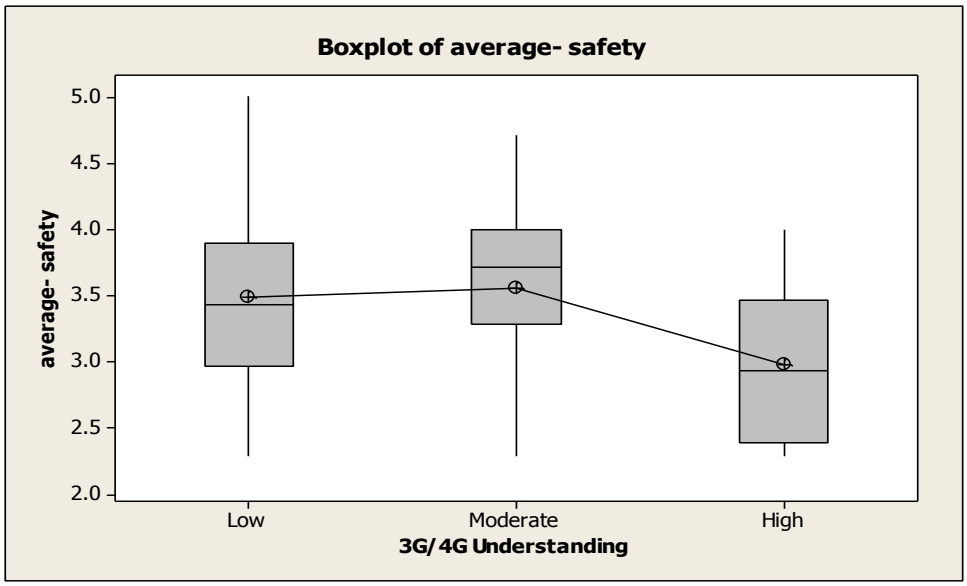

Figure 58. Boxplot of average-safety versus 3G/4G Understanding

Figure 58 confirms the statistical analysis. Participants with little to no understanding of the 3G/4G network technologies had the widest range of responses. Participants with a strong understanding had the smallest range and the lowest safety rating.

Table 26. One-Way ANOVA: Average-Use versus 3G/4G Understanding

```
Source                DF     SS     MS     F      P
3G/4G Understanding    2  0.682  0.341  2.02  0.143
Error                 52  8.777  0.169
Total                 54  9.459

S = 0.4108   R-Sq = 7.21%   R-Sq(adj) = 3.64%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean   StDev  --------+---------+---------+---------+-
1      18  3.2292  0.4912  (--------*---------)
2      31  3.4637  0.3697               (------*-------)
3       6  3.4792  0.3393       (----------------*----------------)
                          --------+---------+---------+---------+-
                                3.20      3.40      3.60      3.80

Pooled StDev = 0.4108
```

Statistical analysis showed no statistically significant effect of participants' understanding of 3G/4G networks on participants' average use ratings. The means for low,

moderate and high understanding (3.2292, 3.4637, and 3.4792 respectively) were similar and participants of all understanding levels had a mean greater than three.

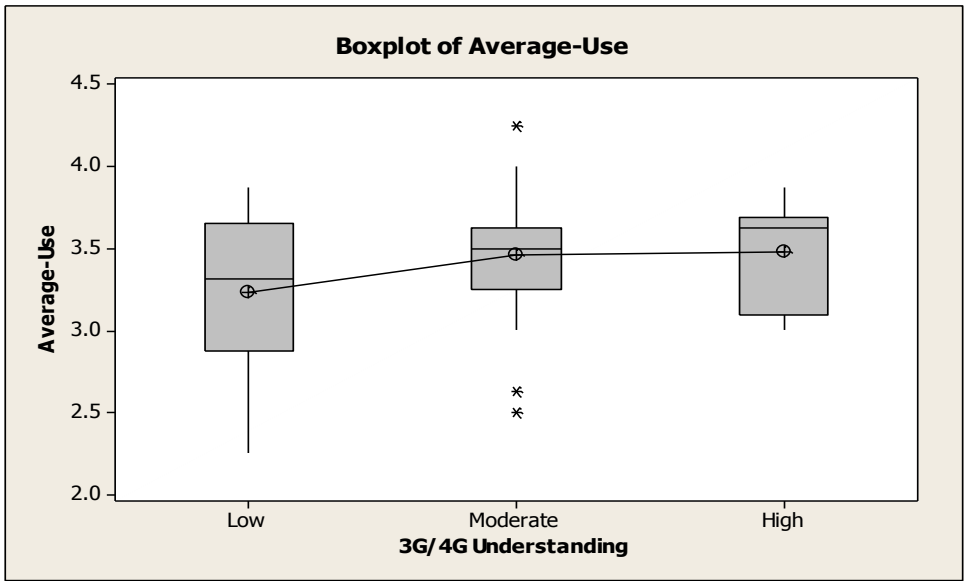

Figure 59. Boxplot of Average-Use versus 3G/4G Understanding

Figure 59 confirms the statistical analysis. Only the low understanding level noticed a wide range of results.

Table 27. One-Way ANOVA: average-3G versus 3G/4G Understanding

```
Source                DF      SS     MS     F      P
3G/4G Understanding    2   1.241  0.621  1.51  0.231
Error                 52  21.427  0.412
Total                 54  22.668

S = 0.6419   R-Sq = 5.48%   R-Sq(adj) = 1.84%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean   StDev  ----+---------+---------+---------+-----
1      18  3.5972  0.7270               (---------*---------)
2      31  3.8266  0.5171                         (-------*------)
3       6  3.3958  0.9401  (-----------------*-----------------)
                          ----+---------+---------+---------+-----
                            3.00      3.30      3.60      3.90

Pooled StDev = 0.6419
```

Statistical analysis showed no statistically significant effect of participants' understanding of 3G/4G networks on average safety ratings on a 3G or 4G network. The means for low, moderate and high understanding were similar and all levels of understanding had a mean that favored feeling safe (greater than three) when utilizing a 3G or 4G network.

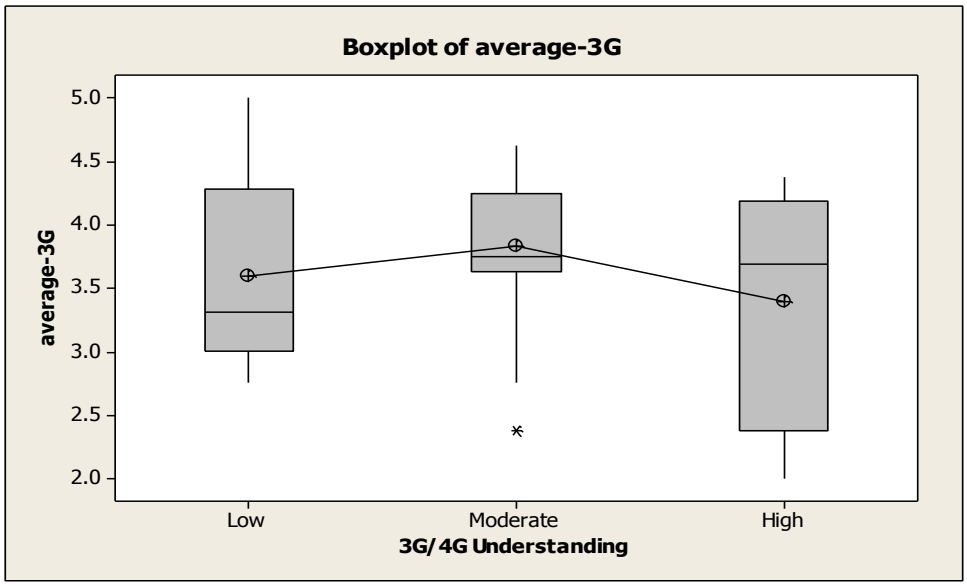

Figure 60. Boxplot of average-3G versus 3G/4G Understanding

Figure 60 confirms the statistical analysis and shows that only participants in the low level of understanding had any results with a safety rating of five.

Table 28. One-Way ANOVA: average-Wi-Fi versus 3G/4G Understanding

```
Source                DF      SS     MS     F      P
3G/4G Understanding    2   1.237  0.618  1.29  0.283
Error                 52  24.864  0.478
Total                 54  26.101

S = 0.6915   R-Sq = 4.74%   R-Sq(adj) = 1.07%


                              Individual 95% CIs For Mean Based on
                              Pooled StDev
Level    N    Mean   StDev  -------+---------+---------+---------
+--
1       18  3.7986  0.6602                  (---------*--------)
2       31  3.9435  0.6454                           (------*------
)
3        6  3.4583  0.9958  (---------------*---------------)
                            -------+---------+---------+---------
+--
                                 3.15      3.50      3.85
4.20

Pooled StDev = 0.6915
```

Statistical analysis showed no statistically significant effect of participants' understanding of Wi-Fi networks on average safety ratings. The means for low, moderate and high understanding were similar and all levels of understanding had a mean that favored feeling safe (greater than three) when utilizing a Wi-Fi network.

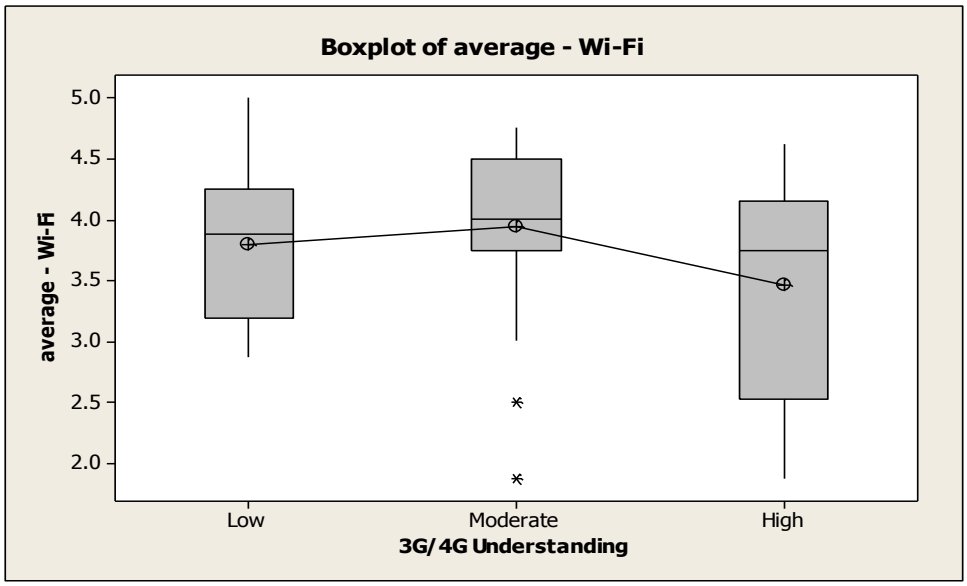

Figure 61. Boxplot of average-Wi-Fi versus 3G/4G Understanding

Figure 61 confirms the statistical analysis and shows that only participants in the low level of understanding had any result with a safety rating of five.

Table 29. One-way ANOVA: 3G/4G networks are more convenient versus 3G/4G Understanding

```
Source                DF      SS    MS     F      P
3G/4G Understanding    2    3.66  1.83  1.26  0.292
Error                 52   75.33  1.45
Total                 54   78.98

S = 1.204   R-Sq = 4.63%   R-Sq(adj) = 0.96%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N   Mean  StDev   -+---------+---------+---------+------
--
1      18  3.889  1.132                      (--------*-------)
2      31  3.581  1.285                    (-----*-----)
3       6  3.000  0.894   (-------------*-------------)
                          -+---------+---------+---------+------
--
                         2.10      2.80      3.50      4.20

Pooled StDev = 1.204
```

Statistical analysis showed no statistically significant effect of participants' understanding of 3G/4G networks on the feeling that 3G/4G networks are more convenient than Wi-Fi networks. The means for low, moderate and high understanding were similar and participants tended to feel that 3G/4G networks are more convenient.

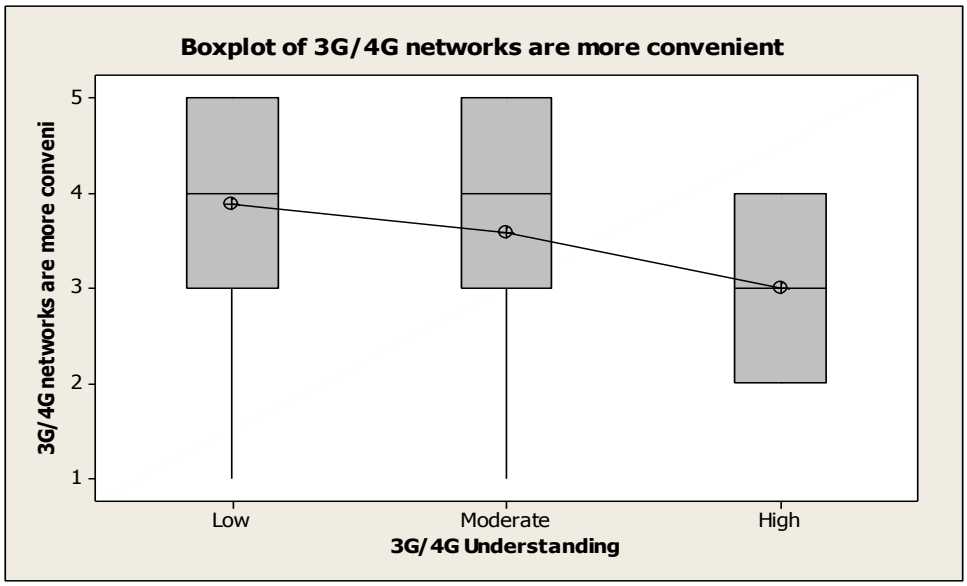

Figure 62. Boxplot of 3G/4G networks are more convenient

Figure 62 confirms the statistical analysis. The means are all similar. As the understanding of 3G/4G networks increased, the means lowered at each increase in 3G/4G understanding.

Table 30. One-way ANOVA: I prefer using Wi-Fi networks versus 3G/4G Understanding

```
Source                DF     SS    MS     F      P
3G/4G Understanding    2   9.39  4.70  3.16  0.050
Error                 52  77.15  1.48
Total                 54  86.55

S = 1.218   R-Sq = 10.85%   R-Sq(adj) = 7.42%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N   Mean  StDev   ---+---------+---------+---------+-----
-
1      18  2.722  1.406   (------*------)
2      31  3.097  1.165         (-----*----)
3       6  4.167  0.753                (-----------*------------)
                          ---+---------+---------+---------+-----
-
                           2.40      3.20      4.00      4.80

Pooled StDev = 1.218
```

Statistical analysis showed no statistically significant effect of participants' understanding of 3G/4G networks on the feeling that 3G/4G networks are more convenient than Wi-Fi networks. The means for low, moderate and high understanding did vary though. The p-value was exactly 0.05, which means the means were almost different enough to claim a significant difference.

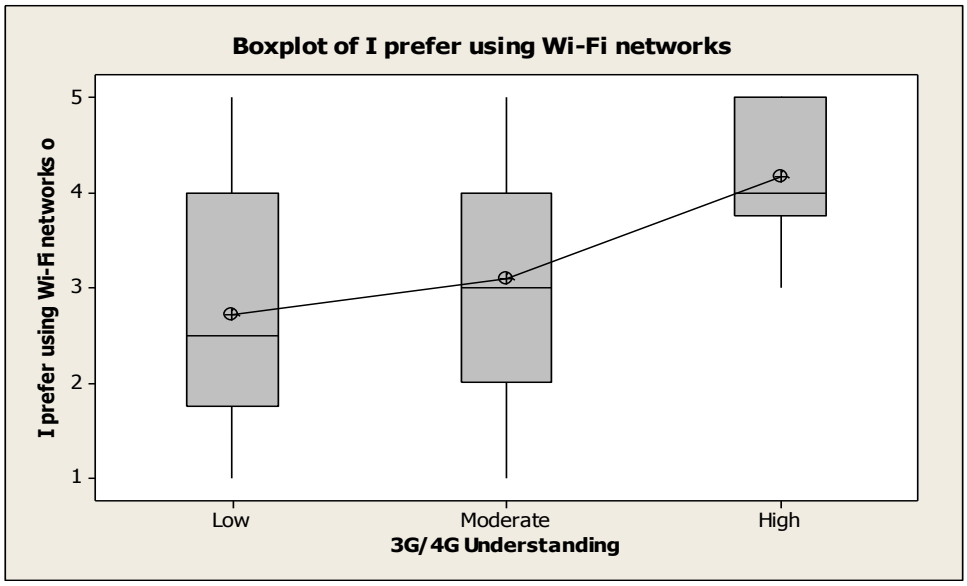

Figure 63. Boxplot of I prefer using Wi-Fi networks

Figure 63 confirms the statistical analysis. The means are similar for the first two levels of understanding, but the high understanding level had a higher mean.

Chapter 6: Analysis of Results

Statements from the survey have been divided into six groups: knowledge, preference, security, rating, frequency of user actions, and descriptions of reasoning. Using this classification to analyze the responses will help understand how participants feel about each area in addition to the overall topics.

Knowledge

Four of the statements were related to general knowledge in the area of smartphones and networks. Statements K1, K2, and K3 were based off of a three-point personal rating of the participant's own knowledge of the networks and overall technical skill. Statement K4 was based off of the five-point Likert scale. These results were analyzed using a one sample t-test with a 95% confidence interval. Statement K1 had a statistically significant mean of 2.1935. The p-value (0.027) was less than 0.05. This means that participants believed they had better than a moderate understanding of Wi-Fi networks. Statement K2 had a statistically significant mean of 1.7419 with a p-value of 0.002. The participants believed they had less than a moderate understanding of 3G and 4G networks. Statement K3 had a statistically significant mean of 2.4677 with a p-value of 0.000. The participants believed they had between a moderate and high level of technical skill. Statement K4 did not have a statistically significant mean (3.127), as the p-value of 0.278 was greater than 0.05. The participants slightly agreed with the idea that a 3G or 4G network is more secure than a Wi-Fi network.

These results indicate that participants do not have as strong of an understanding of 3G and 4G networks as they do Wi-Fi networks. The participants have a strong background in

general technologies such as using the internet for web browsing, email, gaming, and media consumption, and many participants can troubleshoot technological problems.

Factor analysis for these knowledge statements revealed that technical skill was a factor in the responses to both statements K1 and K2. For each case, participants identifying themselves as being at a high technical skill level were shown to have a better understanding of both 3G/4G networks and Wi-Fi networks. This is a foundation for understanding how technical people learn more about networks than non-technical people.

Gender was shown to be a factor for statements K1 and K3. Male participants were shown to have a better understanding of Wi-Fi networks, and males were also shown to have a greater level of technical skill. This information is useful in order to understand the demographics of technical people.

Preference

Two of the statements were related to the participants' preferences regarding network selection. Statements P1 and P2 were based off of the five-point Likert scale. These results were analyzed using a one sample t-test with a 95% confidence interval. Statement P1 had a statistically significant mean of 3.618. The p-value (0.000) was less than 0.05. This means that participants felt that 3G and 4G networks are more convenient than Wi-Fi networks when using a smartphone. Statement P2 did not have a statistically significant mean (3.091). The p-value was 0.597. This means that participants do not have a preference of using a Wi-Fi network instead of a 3G or 4G network. In summary, the participants believe that 3G and 4G networks are more convenient than Wi-Fi networks, but they do not have a preference of using the 3G and 4G networks just because it is convenient to do so.

Factor analysis for these preference statements revealed that technical skill was a factor for statement P1. Participants with moderate technical skill agreed that 3G/4G networks are more convenient than Wi-Fi networks, while participants with higher technical skill only slightly agreed. Technical expertise tended toward preferring Wi-Fi networks for convenience, but those participants still felt 3G/4G networks were more convenient for smartphone use.

Wi-Fi understanding was shown to be a factor for statement P2. Participants with a strong understanding of Wi-Fi networks preferred using Wi-Fi networks much more than at other levels of understanding. This makes sense because understanding the networks in great detail could certainly influence a preference over a network of which that participant may not have been as knowledgeable.

3G/4G understanding was not shown to be a factor for either statement, but the results were important. For statement P2, the p-value was 0.05, which means it was as close to being significant as it possibly could have been without reaching statistical significance. These results are important because they reveal that as the participants' understanding of 3G/4G increased, their preference for networks switched from 3G/4G networks to Wi-Fi networks. As the participants learned more about 3G/4G networks, they tended to prefer Wi-Fi networks more.

Security

Ten of the statements were related to the participants' feelings of safety. The first three (S1-S3) were related to feelings of safety when connecting to networks. The final seven were related to feelings of safety when performing certain actions using a smartphone. Each of the ten statements was based off of the five-point Likert scale. These results were analyzed using a one sample t-test with a 95% confidence interval. Statement S1 had a statistically significant mean of 2.345. The p-value (0.000) was less than 0.05. This means that participants feel unsafe using a Wi-Fi network that does not require a connection password. Statement S2 had a statistically significant mean of 3.4182. The p-value was 0.000. This means that participants feel safe using Wi-Fi networks that are password protected. Statement S3 had a statistically significant mean of 3.273. The p-value was 0.021. This means that participants feel safe using a 3G or 4G network because they trust the phone carrier. Statement S4 had a statistically significant mean of 4.036. The p-value was 0.000. This means that participants feel strongly that they are safe when sending and receiving text messages to their smartphones. Statement S5 had a statistically significant mean of 3.855. The p-value was 0.000. This means that participants feel safe using mobile applications on their smartphones. Statement S6 had a statistically significant mean of 3.655. The p-value was 0.000. This means that participants feel safe using social networking sites on their smartphones. Statement S7 had a statistically significant mean of 2.673. The p-value was 0.010. This means that participants feel unsafe moving stock using their smartphones. Statement S8 did not have a statistically significant mean. The p-value (0.472) was greater than 0.05. This means that participants did not have any strong feelings about their safety, positively or negatively, when making online purchases using their smartphones. Statement S9 did not have a statistically significant mean. The p-value was 0.821. This means that participants did not have any strong

feelings about their safety, positively or negatively, when utilizing mobile banking on their smartphones. However, statements S8 and S9 had many three (neutral) ratings, which could mean that participants were indifferent, did not have an opinion, or had not performed these actions using their smartphones. S10 had a statistically significant mean of 4.145. The p-value was 0.000. This means that participants feel strongly that they are safe when sending and receiving emails using their smartphones.

Factor analysis for these statements was completed by averaging the scores across all questions. This collective average allows for an overall view of the participants' feelings of safety when using their smartphones. None of the potential factors used for this research proved to be a factor in safety ratings of the participants. Feelings regarding personal safety did not vary by the participant's gender, understanding of either type of network, or technical skill.

These results are important because it signifies a basic consensus when it comes to security of networks and smartphones. The participants feel safe when using a password protected network or a 3G/4G network, but they feel unsafe using a Wi-Fi network that is not password protected. Participants feel safe when performing routine actions such as texting, web browsing, emailing, using social networking sites, and using mobile applications. These are relatively safe actions to perform with the exception of using mobile applications. This result is troublesome because of recent changes that have led attackers to use mobile applications with much greater frequency for attacks (*Symantec Report Finds Cyber Threats Skyrocket in Volume and Sophistication*)**.**

Rating

Sixteen of the statements were related to the participants' rated levels of security when performing specific actions over a specific type of network. The first eight statements (R1-R8) were related to rated levels of security when using a 3G or 4G network. The final eight statements (R9-R16) were related to rated levels of security when using a Wi-Fi network. Each of the sixteen statements was based off of the five-point Likert scale. These results were analyzed using a one sample t-test with a 95% confidence interval.

Statement R1 had a statistically significant mean of 4.600. The p-value (0.000) was less than 0.05. This means participants feel very safe texting when connected to a 3G or 4G network. Statement R2 had a statistically significant mean of 4.3818. The p-value was 0.000. This means participants feel very safe emailing when connected to a 3G or 4G network. Statement R3 had a statistically significant mean of 4.291. The p-value was 0.000. This means participants feel very safe browsing the web when connected to a 3G or 4G network. Statement R4 did not have a statistically significant mean. The p-value (0.592) was greater than 0.05. This means participants do not feel strongly either way regarding their safety while banking on their smartphone connected to a 3G or 4G network. Statement R5 had a statistically significant mean of 2.400. The p-value was 0.000. This means participants do not feel safe moving stock when using a 3G or 4G network. Statement R6 had a statistically significant mean of 2.618. The p-value was 0.000. This means participants do not feel safe making online purchases when connected to a 3G or 4G network. Statement R7 had a statistically significant mean of 4.091. The p-value was 0.000. This means participants feel very safe using social networking sites when connected to a 3G or 4G network. Statement R8 had a statistically significant mean of 4.345. The p-value was 0.000. This

means participants feel very safe using mobile applications when connected to a 3G or 4G network.

Statement R9 had a statistically significant mean of 4.436. The p-value was 0.000. This means participants feel very safe texting when connected to a Wi-Fi network. Statement R10 had a statistically significant mean of 4.418. The p-value was 0.000. This means participants feel very safe emailing when connected to a Wi-Fi network. Statement R11 had a statistically significant mean of 4.400. The p-value was 0.000. This means participants feel very safe browsing the web when connected to a Wi-Fi network. Statement R12 did not have a statistically significant mean. The p-value was 0.255. This means participants do not feel strongly either way regarding their safety when mobile banking when connected to a Wi-Fi network. Statement R13 did not have a statistically significant mean. The p-value was 0.096. This means participants do not feel strongly either way regarding their safety when moving stock when connected to a Wi-Fi network. Statement R14 did not have a statistically significant mean. The p-value was 1.000. This means participants are neutral in regards to their safety when making online purchases when connected to a Wi-Fi network. Statement R15 had a statistically significant mean of 4.182. The p-value was 0.000. This means participants feel very safe using social networking sites when connected to a Wi-Fi network. Statement R16 had a statistically significant mean of 4.364. The p-value was 0.000. This means participants feel very safe using mobile applications when connected to a Wi-Fi network.

Factor analysis for these statements was completed by averaging the scores for each of the networks. R1-R8 were grouped and averaged as a collective security score for 3G and 4G networks. R9-R16 were grouped and averaged as a collective security score for Wi-Fi networks. These collective averages allow for an overall view of the participants' feelings of safety when

connected to each type of network. None of the potential factors used for this research proved to be a factor in network-specific safety ratings of the participants. Results did not vary significantly by the participant's gender, understanding of either type of network, or technical skill.

These results are important because they reveal that participants generally agreed on the levels of safety and security when performing specific actions over different types of networks. While not statistically significant, it is imperative to note that across all statements except R1, participants feel safer when performing comparable actions over a Wi-Fi network than over a 3G/4G network. This is pertinent because participants may favor Wi-Fi networks due to their higher feeling of security and safety on those networks.

User Frequency

One of the statements was related to the frequency at which participants perform specific actions using their smartphone. Statement U1 asked the participants to rate the frequency at which they perform specific action on a five-point scale that ranged from “Never” to “Several times daily”.

Texting, emailing, web browsing, using social networking sites, and using mobile applications were the most frequent actions conducted. Each of these actions had a mean between four (daily) and five (several times daily). This is not surprising, but the frequency of the use of mobile applications joined with the aforementioned strong feeling of security using mobile applications leaves participants at risk considering the increase in malware found in mobile applications.

Mobile banking, E-commerce, and moving stock were all very infrequent actions among participants. The means ranged from two (rarely) to nearly one (never). The infrequency of these actions is likely a combination of feelings of insecurity and the age group of the participants. Participants ages 18-24 would be less likely than older age groups to be involved in high volumes of banking, moving stock, or online purchasing. However, the extremely low frequencies of these actions are important considering the overall frequency at which the participants reported using their smartphones.

Descriptions of Reason

Two of the statements were related to giving reasons for choosing a particular network to perform actions. Statement D1 asked the participants to give reasons for choosing a Wi-Fi network to perform smartphone actions. Speed, convenience, security, and personal preference were the most frequent responses. Statement D2 asked the participants to give reasons for choosing a 3G/4G network to perform smartphone actions. Convenience, speed, and not having a Wi-Fi compatible smartphone were the most frequent responses.

The switching of speed and convenience as the reason for choosing a network is the most important comparison to understand. In addition to establishing that participants feel safer using Wi-Fi networks than 3G/4G networks, evidence arises that 3G/4G networks are often chosen because they are more convenient for the participant. Wi-Fi networks, however, are chosen more frequently because of speed and security than 3G/4G networks.

These results are important for smartphone companies because they should aim to strengthen the security of mobile networks. The charge of a data plan, combined with a feeling of insecurity, could quickly lead users to use Wi-Fi networks more often.

Chapter 7: Conclusions

Categorizing the survey statements into groups helped make sense of the overall analysis. The participants in this study were familiar with and knowledgeable of smartphones and networks, in addition to having a strong technical background. It is clear that this age group (18-24) has a strong foundation in current technologies. Participants were far less knowledgeable when considering 3G and 4G networks than Wi-Fi networks. This seems to be a combination of how quickly and recently smartphones and mobile phone networks have become popular and widespread. As a whole, the participants were unsure whether 3G and 4G networks or Wi-Fi networks are safer for use of a smartphone. Increased awareness to the public about the weaknesses of 3G and 4G networks should be a main focus of news media and technical journals.

The participants felt 3G and 4G networks were much more convenient than Wi-Fi networks for smartphone use. Despite this convenience advantage, participants still did not favor 3G and 4G networks over Wi-Fi networks. Participants felt more comfortable performing every action, except for texting, using a Wi-Fi network. The combination of these two results leads me to believe that phone carriers must strengthen and improve their mobile networks. Implementation of a 4G network will greatly increase speed, but security must also increase. Phone carriers need to show that there are safeguards against attacks. Anti-virus and anti-malware software should either be offered as a package or come preloaded on smartphones. Smartphones are smaller computers, and they need to be protected in the same manner.

Participants felt very safe when performing most actions on their smartphones. Specifically, participants felt the safest when texting, emailing, web browsing, using social networking sites, and using mobile applications. The population must be made aware of increasing smartphone attacks, especially involving mobile applications. It seems people are unaware of these risks, judging by the lack of frequency in other actions that may be dangerous while maintaining a high frequency in the use of mobile applications.

Participants felt unsafe when using their smartphones to move stock. In addition, participants felt unsafe using a Wi-Fi network that did not require a password. These results are welcoming, because both actions pose a definite risk to the user.

From the analysis, it is evident that there are differences in opinions. Some of these disparities may be caused by personal factors, but education may also play a large role. Informing the population about new smartphone and network technologies, functions, capabilities, and weaknesses may help in discovering how the people feel about these technologies. With the right information, the general population would be better prepared to protect themselves from attackers and avoid situations that may be especially risky.

Finally, it is important to note that a statistically significant result does not necessarily lead to any practical implications. The difference between a mean of 3.1 and 2.9 may be statistically significant, but both fall in the “neither agree nor disagree” region and may not provide any practical difference.

Limitations

The conclusions established from this study are not without limitations. The sample may not be representative of the population for a few reasons. The survey was shared through email lists, as well as mentioned in classrooms, and the entire survey was delivered through an online survey tool. The demographics collected in the research help to show diversity; however, the method of solicitation assumes access to, and some proficiency with, email, a computer, and the Internet. The participants had some sort of a connection with the administrator of the study, specifically either through an email list or an accessible classroom. The population was also limited to a large university in Pennsylvania, which means it is not necessarily representative of other areas or universities.

Another limitation was in the nature of the responses, specifically with the use of "neither agree nor disagree" and "indifferent" as the neutral values (three) for the 5-point scales. While these choices have an apparent meaning, they could also indicate that the participant either has not formed an opinion about an issue, they did not care about the issue, or that the participant does not know enough information to offer an opinion. Further, the "indifferent" response could also indicate that the participant had not ever performed a particular action on a smartphone. It is impossible to discern whether the response was truly a "neither agree nor disagree" or "indifferent", or if the response was an "I don't know" or "I don't care".

Improvements and Future Research

In spite of the grounds this study covered relating to smartphone use and network trust, there are ways that it could be improved and expanded upon. The first improvement would be obtaining a sample that is both more randomized and representative. The results of the study could then be more accurately generalized to the general population. Adding more sections of questions that can relate specific actions with the reasons they use their smartphone to perform them, as opposed to a computer or other means.

Future research could add greatly to this study in several ways. Additional factors would be a strong starting point for future research, including areas such as occupation, education, number of children, income, and global location. Delving into these factors, or interactions between these factors, would allow for a more complete analysis and therefore a deeper understanding of the participants' responses. Future research can look at exactly how background knowledge and occupation work together to shape opinions and actions of participants. A future study could also look into funding in order to possibly pay for a trial-time participation study that involves real data using issued smartphones.

This study may not be applicable to the general population, because of the limitations described above, but it does offer a starting point for further research into public knowledge, perception, preferences and usage regarding smartphones and networks.

Appendix A: Research Survey

Research Survey

Informed Consent

Conducted as part of the undergraduate thesis requirement for the Schreyer Honors College, The Pennsylvania State University

Please read this consent document carefully before you decide to participate in this study.

Purpose of the research study:

This study is designed to determine what actions smartphone users are performing over various networks, and also users' knowledge of smartphones and mobile networks.

What you will be asked to do in this study:

You will be asked to answer some multiple choice questions about your mobile-phone knowledge and usage, as well as your opinions about and understanding of the technology.

Time required:

20-30 minutes

Risks:

There are no anticipated discomforts in completing this survey. You can withdraw from participation at any stage of the survey.

Compensation and Benefit:

The results will be used to benefit undergraduate research at Penn State University.

Confidentiality:

Your identity will be kept confidential as required by law. Your name will never appear in any related report. No identifying information will be gathered. All responses are anonymous. No guarantees can be made regarding interception of data sent via the internet by any third parties.

Voluntary Participation:

Your participation in this study is completely voluntary. There is no penalty for not participating.

Right to withdraw from the study:

You may withdraw from the study at any time without consequence.

Point of contact for questions related to the study:

Jeff Dean, Undergraduate Student in the College of Information Sciences and Technology, Pennsylvania State University, jmd569@psu.edu.

Agreement:

I have read the above information. Clicking on the "Next" button below indicates that I voluntarily agree to participate in the survey.

To retain a copy of this informed consent document, print this page now or contact Jeff Dean (as listed above).

Definitions

For this survey, please use the following definitions when answering the questions:

3G/4G Network: Cellular networks that allow users to transmit video, graphics, and other media. This is the standard network that phone companies supply if you purchase a data plan.

Wi-Fi Network: A wireless, local area network that often has a range of a few hundred feet. (Examples include home wireless networks, and networks in cafes, restaurants, planes and other public locations.

Smartphone: A mobile phone that offers advanced features such as voice, messaging, e-mail, and Internet capabilities.

Demographics and other independent variables

1. **What is your gender?** Male Female Prefer not to answer

2. **What is your age?** 18-24 25-34 35-44 45-54 55-64 65+ Prefer not to answer

3. **Which type of smartphone do you own?**

   Android

   iPhone

   Blackberry

   HTC

   Samsung

   Nokia

   T-Mobile

I do not own a smartphone

Other (please specify)

4. **How would you rate your overall understanding of Wi-Fi Networks?**

   Low (Little to no understanding of how the technology works)

   Moderate (Some understanding of the technology and how the service is provided)

   High (Strong understanding of the technology and methods used to provide the service)

5. **How would you rate your overall understanding of 3G/4G Networks?**

   Low (Little to no understanding of how the technology works)

   Moderate (Some understanding of the technology and how the service is provided)

   High (Strong understanding of the technology and methods used to provide the service)

6. **How would you rate your overall technical skill level?**

   Low (Uncomfortable with technology and struggle with basic tasks such as web browsing or email)

   Moderate (Comfortable using technology for tasks such as web browsing, email, gaming, or media consumption)

   High (Extremely comfortable with technology and can troubleshoot problems for myself and others)

7. **Please rate your level of agreement with the following statements on a 1-5 scale with 1 meaning strongly disagree, 3 meaning neither agree nor disagree, and 5 meaning strongly agree.**

   3G/4G networks are more convenient than Wi-Fi networks for smartphone use.

   3G/4G networks are more secure than Wi-Fi networks.

   I prefer using Wi-Fi networks over using 3G/4G networks.

   I feel safe using a Wi-Fi network that does not require a password.

   I feel safe using Wi-Fi networks that are password protected because they are safer than 3G/4G networks.

I feel safe using 3G/4G networks because the phone carrier can be trusted.

I feel safe when sending and receiving text messages on my smartphone.

I feel safe when using mobile applications (apps) on my smartphone.

I feel safe when using social networking sites on my smartphone.

I feel safe when buying/selling/trading stock from my smartphone.

I feel safe when making online purchases from my smartphone.

I feel safe when mobile banking from my smartphone.

I feel safe when sending and receiving emails from my smartphone.

8. **Please indicate the frequency in which you perform particular tasks using your smartphone on a 1-5 scale with 1 meaning never, 2 meaning rarely, 3 meaning once or twice a week, 4 meaning daily, and 5 meaning several times daily.**

   Texting

   Email

   Web Browsing

   Mobile Banking

   Buying/Selling/Trading Stock

   E-Commerce (Online Purchases or Sales)

   Social Networking

   Use of Mobile Applications (Apps)

9. **Which of these describe reasons you use Wi-Fi networks to perform actions on your smartphone? Select all that apply.**

   Convenience

   Speed

   Security

   Trust (in Wi-Fi network supplier)

   Lack of trust in 3G/4G networks

   No 3G/4G data plan on my smartphone

   Personal Preference

I do not use Wi-Fi networks on my smartphone

Other (please specify)

10. **Which of these describe reasons you use 3G/4G networks to perform actions on your smartphone? Select all that apply.**

    Convenience

    Speed

    Security

    Trust (in Wi-Fi network supplier)

    Lack of trust in 3G/4G networks

    No 3G/4G data plan on my smartphone

    Personal Preference

    I do not use Wi-Fi networks on my smartphone

    Other (please specify)

11. **Rate your level of comfort (security/safety) using your smartphone to perform the following actions over 3G/4G networks on a 1-5 scale with 1 being very uncomfortable, 3 being indifferent, and 5 being very comfortable.**

    Texting

    Email

    Web Browsing

    Mobile Banking

    Buying/Selling/Trading Stock

    E-Commerce (Online Purchases or Sales)

    Social Networking

    Use of Mobile Applications (Apps)

12. **Rate your level of comfort (security/safety) using your smartphone to perform the following actions over Wi-Fi networks on a 1-5 scale with 1 being very uncomfortable, 3 being indifferent, and 5 being very comfortable.**

    Texting

    Email

Web Browsing

Mobile Banking

Buying/Selling/Trading Stock

E-Commerce (Online Purchases or Sales)

Social Networking

Use of Mobile Applications (Apps)

13. **Do you take any specific precautions before performing any of the following actions on your smartphone? Select all actions that you take specific precautions before performing. If you select none, explain why (strong feeling of security, not sure what precautions to take, etc.).**

    Texting

    Email

    Web Browsing

    Buying/Selling/Trading Stock

    E-Commerce (Online Purchases or Sales)

    Social Networking

    Use of Mobile Applications (Apps)

    None (explain why)

14. **If you selected any of the previous actions, specify which precautions you take in the space below**

15. **If you are in IST 456 with Dr. Santoro, enter your email here so that you can be credited with having completed the survey in order to get extra credit. If you are not in IST 456 with Dr. Santoro, you can ignore this part and click "Done".**

Appendix B: Two Sample T-Test Results for Gender Factor

Two-Sample T-Test and CI: average- safety, Gender

```
Two-sample T for average- safety

Gender   N   Mean  StDev  SE Mean
1       35  3.441  0.588    0.099
2       20  3.521  0.733     0.16

Difference = mu (1) - mu (2)
Estimate for difference:  -0.081
95% CI for difference:  (-0.471, 0.310)
T-Test of difference = 0 (vs not =): T-Value = -0.42  P-Value = 0.677  DF = 33
```

Two-Sample T-Test and CI: Average-Use, Gender

```
Two-sample T for Average-Use

Gender   N   Mean  StDev  SE Mean
1       35  3.371  0.386    0.065
2       20  3.419  0.479     0.11

Difference = mu (1) - mu (2)
Estimate for difference:  -0.047
95% CI for difference:  (-0.302, 0.208)
T-Test of difference = 0 (vs not =): T-Value = -0.38  P-Value = 0.708  DF = 33
```

Two-Sample T-Test and CI: average-3G, Gender

```
Two-sample T for average-3G

Gender   N   Mean  StDev  SE Mean
1       35  3.671  0.524    0.089
2       20  3.763  0.834     0.19

Difference = mu (1) - mu (2)
Estimate for difference:  -0.091
95% CI for difference:  (-0.515, 0.333)
T-Test of difference = 0 (vs not =): T-Value = -0.44  P-Value = 0.663  DF = 27
```

Two-Sample T-Test and CI: average - Wi-Fi, Gender

```
Two-sample T for average - Wi-Fi

Gender   N   Mean  StDev  SE Mean
1       35  3.836  0.706     0.12
2       20  3.856  0.695     0.16

Difference = mu (1) - mu (2)
Estimate for difference:  -0.021
95% CI for difference:  (-0.416, 0.375)
T-Test of difference = 0 (vs not =): T-Value = -0.10  P-Value = 0.917  DF = 40
```

Appendix C: Two Sample T-Test Results for Technical Skill Factor

Two-Sample T-Test and CI: average- safety, Technical Skill

```
Two-sample T for average- safety

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.503  0.701     0.13
3          28  3.439  0.584     0.11

Difference = mu (2) - mu (3)
Estimate for difference:  0.064
95% CI for difference:  (-0.286, 0.414)
T-Test of difference = 0 (vs not =): T-Value = 0.37  P-Value = 0.716  DF = 50
```

Two-Sample T-Test and CI: Average-Use, Technical Skill

```
Two-sample T for Average-Use

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.384  0.433    0.083
3          28  3.393  0.412    0.078

Difference = mu (2) - mu (3)
Estimate for difference:  -0.009
95% CI for difference:  (-0.237, 0.220)
T-Test of difference = 0 (vs not =): T-Value = -0.08  P-Value = 0.940  DF = 52
```

Two-Sample T-Test and CI: average-3G, Technical Skill

```
Two-sample T for average-3G

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.713  0.600     0.12
3          28  3.696  0.702     0.13

Difference = mu (2) - mu (3)
Estimate for difference:  0.017
95% CI for difference:  (-0.336, 0.369)
T-Test of difference = 0 (vs not =): T-Value = 0.09  P-Value = 0.925  DF = 52
```

Two-Sample T-Test and CI: average - Wi-Fi, Technical Skill

```
Two-sample T for average - Wi-Fi

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.824  0.563     0.11
3          28  3.862  0.813     0.15

Difference = mu (2) - mu (3)
Estimate for difference:  -0.038
95% CI for difference:  (-0.415, 0.340)
T-Test of difference = 0 (vs not =): T-Value = -0.20  P-Value = 0.843  DF = 48
```

Two-Sample T-Test and CI: 3G/4G networks are more secure, Technical Skill

```
Two-sample T for 3G/4G networks are more secure

Technical
Skill       N   Mean  StDev  SE Mean
2          27  3.259  0.813     0.16
3          28  3.000  0.903     0.17

Difference = mu (2) - mu (3)
Estimate for difference:  0.259
95% CI for difference:  (-0.205, 0.724)
T-Test of difference = 0 (vs not =): T-Value = 1.12  P-Value = 0.268  DF = 52
```

Two-Sample T-Test and CI: I feel safe using a Wi-Fi network without a password, Technical Skill

```
Two-sample T for I feel safe using a Wi-Fi netwo

Technical
Skill       N  Mean  StDev  SE Mean
2          27  2.85   1.23     0.24
3          28  1.86   1.18     0.22

Difference = mu (2) - mu (3)
Estimate for difference:  0.995
95% CI for difference:  (0.342, 1.647)
T-Test of difference = 0 (vs not =): T-Value = 3.06  P-Value = 0.003  DF = 52
```

Appendix D: ANOVA Results for Understanding of Wi-Fi Factor

One-way ANOVA: average- safety versus Wi-Fi Understanding

```
Source                DF      SS     MS     F      P
Wi-Fi Understanding    2   0.606  0.303  0.73  0.485
Error                 52  21.462  0.413
Total                 54  22.068

S = 0.6424   R-Sq = 2.75%   R-Sq(adj) = 0.00%

                            Individual 95% CIs For Mean Based on Pooled StDev
Level    N    Mean   StDev    +---------+---------+---------+---------
1        7  3.4898  0.7278    (-------------------*-------------------)
2       27  3.5661  0.6246                 (---------*---------)
3       21  3.3401  0.6380       (-----------*----------)
                              +---------+---------+---------+---------
                            3.00      3.25      3.50      3.75
Pooled StDev = 0.6424
```

One-way ANOVA: Average-Use versus Wi-Fi Understanding

```
Source                DF     SS     MS     F      P
Wi-Fi Understanding    2  1.228  0.614  3.88  0.027
Error                 52  8.230  0.158
Total                 54  9.459

S = 0.3978   R-Sq = 12.99%   R-Sq(adj) = 9.64%

                            Individual 95% CIs For Mean Based on
                            Pooled StDev
Level    N    Mean   StDev  --------+---------+---------+---------+-
1        7  3.0893  0.4661  (-----------*-----------)
2       27  3.5231  0.3502                        (-----*-----)
3       21  3.3155  0.4323               (------*------)
                            --------+---------+---------+---------+-
                                  3.00      3.25      3.50      3.75
Pooled StDev = 0.3978
```

One-way ANOVA: average-3G versus Wi-Fi Understanding

```
Source                DF      SS     MS     F      P
Wi-Fi Understanding    2   1.626  0.813  2.01  0.144
Error                 52  21.042  0.405
Total                 54  22.668

S = 0.6361   R-Sq = 7.17%   R-Sq(adj) = 3.60%

                            Individual 95% CIs For Mean Based on
                            Pooled StDev
Level    N    Mean   StDev  --------+---------+---------+---------+-
1        7  3.5357  0.6280  (---------------*---------------)
2       27  3.8796  0.5939                    (-------*--------)
3       21  3.5357  0.6894         (--------*--------)
                            --------+---------+---------+---------+-
                                  3.30      3.60      3.90      4.20
Pooled StDev = 0.6361
```

One-way ANOVA: average - Wi-Fi versus Wi-Fi Understanding

```
Source                DF      SS     MS     F      P
Wi-Fi Understanding    2   0.828  0.414  0.85  0.432
Error                 52  25.272  0.486
Total                 54  26.101

S = 0.6971   R-Sq = 3.17%   R-Sq(adj) = 0.00%

                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  ------+---------+---------+---------+---
1       7  3.6429  0.5926  (----------------*-----------------)
2      27  3.9630  0.5324                    (--------*--------)
3      21  3.7560  0.8887            (---------*---------)
                           ------+---------+---------+---------+---
                               3.30      3.60      3.90      4.20
Pooled StDev = 0.6971
```

One-way ANOVA: Technical Skill versus Wi-Fi Understanding

```
Source                DF      SS     MS      F      P
Wi-Fi Understanding    2   5.936  2.968  19.76  0.000
Error                 52   7.810  0.150
Total                 54  13.745

S = 0.3875   R-Sq = 43.18%   R-Sq(adj) = 41.00%

                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev   -+---------+---------+---------+--------
1       7  2.0000  0.0000   (-------*--------)
2      27  2.3333  0.4804              (----*---)
3      21  2.9048  0.3008                                (----*----)
                            -+---------+---------+---------+--------
                           1.75      2.10      2.45      2.80
Pooled StDev = 0.3875
```

Appendix E: ANOVA Results for Understanding of 3G/4G Factor

One-way ANOVA: average- safety versus 3G/4G Understanding

```
Source                DF      SS     MS     F      P
3G/4G Understanding    2   1.705  0.852  2.18  0.124
Error                 52  20.364  0.392
Total                 54  22.068

S = 0.6258   R-Sq = 7.72%   R-Sq(adj) = 4.18%

                            Individual 95% CIs For Mean Based on Pooled StDev
Level   N    Mean   StDev    +---------+---------+---------+---------
1      18  3.4841  0.7656                       (--------*-------)
2      31  3.5576  0.5311                           (------*-----)
3       6  2.9762  0.6222    (--------------*--------------)
                            +---------+---------+---------+---------
                           2.45      2.80      3.15      3.50
Pooled StDev = 0.6258
```

One-way ANOVA: Average-Use versus 3G/4G Understanding

```
Source                DF     SS     MS     F      P
3G/4G Understanding    2  0.682  0.341  2.02  0.143
Error                 52  8.777  0.169
Total                 54  9.459

S = 0.4108   R-Sq = 7.21%   R-Sq(adj) = 3.64%

                            Individual 95% CIs For Mean Based on
                            Pooled StDev
Level   N    Mean   StDev  --------+---------+---------+---------+-
1      18  3.2292  0.4912  (--------*---------)
2      31  3.4637  0.3697               (------*-------)
3       6  3.4792  0.3393       (----------------*----------------)
                           --------+---------+---------+---------+-
                                 3.20      3.40      3.60      3.80
Pooled StDev = 0.4108
```

One-way ANOVA: average-3G versus 3G/4G Understanding

```
Source                DF      SS     MS     F      P
3G/4G Understanding    2   1.241  0.621  1.51  0.231
Error                 52  21.427  0.412
Total                 54  22.668

S = 0.6419   R-Sq = 5.48%   R-Sq(adj) = 1.84%

                            Individual 95% CIs For Mean Based on
                            Pooled StDev
Level   N    Mean   StDev  ----+---------+---------+---------+-----
1      18  3.5972  0.7270               (---------*---------)
2      31  3.8266  0.5171                         (-------*------)
3       6  3.3958  0.9401  (----------------*-----------------)
                           ----+---------+---------+---------+-----
                             3.00      3.30      3.60      3.90
Pooled StDev = 0.6419
```

One-way ANOVA: average - Wi-Fi versus 3G/4G Understanding

```
Source                DF      SS     MS     F      P
3G/4G Understanding    2   1.237  0.618  1.29  0.283
Error                 52  24.864  0.478
Total                 54  26.101

S = 0.6915   R-Sq = 4.74%   R-Sq(adj) = 1.07%

                            Individual 95% CIs For Mean Based on
                            Pooled StDev
Level   N    Mean   StDev  -------+---------+---------+---------+--
1      18  3.7986  0.6602                  (---------*--------)
2      31  3.9435  0.6454                        (------*------)
3       6  3.4583  0.9958  (---------------*---------------)
                           -------+---------+---------+---------+--
                                3.15      3.50      3.85      4.20
Pooled StDev = 0.6915
```

One-way ANOVA: Technical Skill versus 3G/4G Understanding

```
Source                DF      SS     MS     F      P
3G/4G Understanding    2   2.446  1.223  5.63  0.006
Error                 52  11.299  0.217
Total                 54  13.745

S = 0.4661   R-Sq = 17.80%   R-Sq(adj) = 14.63%

                            Individual 95% CIs For Mean Based on
                            Pooled StDev
Level   N    Mean   StDev  ---+---------+---------+---------+------
1      18  2.2222  0.4278  (-----*------)
2      31  2.6129  0.4951              (----*---)
3       6  2.8333  0.4082              (----------*----------)
                           ---+---------+---------+---------+------
                            2.10      2.45      2.80      3.15
Pooled StDev = 0.4661
```

Bibliography

"1G - First Generation Networks." *Mobile-phone-driectory.org*. Mobile Phone Directory. Web. 04 Jan. 2012. <http://www.mobile-phone-directory.org/Technology/1G_-_First_Generation/>.

Afanasyev, M, Chen, T, Voelker, G.M, & Snoeren, A.C. (2010). Usage Patterns in an Urban WiFi Network. *IEEE Xplore*, 1359-1361, 1371.

Akhtar, Shakil. "2G-4G Networks: Evolution of Technologies, Standards, and Deployment." 1-7. *Cims.clayton.edu*. UAE University. Web. 02 Jan. 2012. <http://cims.clayton.edu/sakhtar/EncyPaper04.pdf>.

Baxi, Abhishek. "Smartphones: Growing Market and Usage." *Ilovewindowsphone*. 26 Aug. 2011. Web. 12 Feb. 2012. <http://ilovewindowsphone.in/smartphones-growing-market-and-usage/>.

Best, Jo. "Analysis: What Is a Smart Phone?" *Silicon.com*. 13 Feb. 2006. Web. 17 Mar. 2012. <http://www.silicon.com/technology/mobile/2006/02/13/analysis-what-is-a-smart-phone-39156391/>.

Do, Trinh Minh Tri, Jan Blom, and Daniel Gatica-Perez. *Smartphone Usage in the Wild: A Large-scale Analysis of Applications and Context*. Thesis. Switzerland, 2011. *Publications.idiap.ch*. Web. 07 Jan. 2012. <http://publications.idiap.ch/downloads/papers/2011/Do_ICMI_2011.pdf>.

"The Feature Phone Is Dead! Long Live the Feature Phone!" *Pushr*. 15 Oct. 2010. Web. 12 Feb. 2012. <http://pushr.net/2010/10/feature-phone-is-dead-long-live-feature-phone/>.

"Generation App." *Nielsen.com*. 03 Nov. 2011. Web. 18 Mar. 2012. <http://blog.nielsen.com/nielsenwire/?p=29786>.

Hitchcock, Russell. "The Evolution and Future of Wi-Fi (Part 1)." (2009). *Windowsnetworking.com*. TechGenix Ltd, 10 Sept. 2009. Web. 22 Jan. 2012. <http://www.windowsnetworking.com/articles_tutorials/Evolution-future-Wi-Fi-Part1.html>.

Lehembre, Guillaume. "Wi-Fi Security - WEP, WPA, and WPA2." *Hakin9* (2005). *Hsc.fr*. Hakin9, June 2005. Web. 12 Jan. 2012. <http://www.hsc.fr/ressources/articles/hakin9_wifi/hakin9_wifi_EN.pdf>.

Lo, Joseph. "Trojan Horse Attacks." *Irchelp.org*. Internet Relay Chat (IRC) Help, 05 Feb. 2006. Web. 07 Feb. 2012. <http://www.irchelp.org/irchelp/security/trojan.html>.

Lunden, Ingrid. "Smartphone Penetration Approaching Tipping Point As PC Usage Declines." *PaidContent*. 14 Dec. 2011. Web. 19 Feb. 2012. <http://paidcontent.org/article/419-smartphone-penetration-approaching-tipping-point-as-pc-usage-declines-/>.

Lunden, Ingrid. "Smartphone Usage Up 60 Percent; Android Makes Biggest Gains." *MocoNews*. 07 Feb. 2011. Web. 19 Feb. 2012. <http://moconews.net/article/419-smartphone-usage-up-60-percent-android-makes-biggest-gains/>.

"Mobile Enabled Sites." *Techenvy*. Web. 30 Jan. 2012. <http://www.techenvy.co.uk/our-services/web-development/mobile-enabled-sites/>.

Mutchler, Leigh A., J.P. Shim, and Dustin Ormond. "Exploratory Study on Users' Behavior: Smartphone Usage." Thesis. Mississippi State University, 2011. *Aisel.aisnet.org*. 2011. Web. 07 Jan. 2012. <http://aisel.aisnet.org/amcis2011_submissions/418/>.

Neo. "US Smartphone Market Left to RIM, Android and Apple. Android Leading the Pack." *Shanzai.com*. 09 Feb. 2011. Web. 07 Jan. 2012. <http://www.shanzai.com/index.php/news-a-articles/14-news/399-us-smartphone-market-left-to-rim-android-and-apple-android-leading-the-pack.html>.

Shye, A, Scholbrock, B, Memik, G, & Dinda, P.A. (2010). Characterizing and Modeling User Activity on Smartphones: Summary. *IEEE Xplore*, 375-376.

Sims, Martin. "UK Growth in Smartphone Usage Revealed as Largest in Survey of Five Developed Countries." *-PushON*. 26 Jan. 2012. Web. 12 Feb. 2012. <http://www.pushon.co.uk/blog/latest-news/uk-growth-in-smartphone-usage-revealed-as-largest-in-survey-of-five-developed-countries/>.

Smith, Aaron. "Nearly Half of American Adults Are Smartphone Owners." *Pewinternet.org*. 01 Mar. 2012. Web. 19 Mar. 2012. <http://pewinternet.org/Reports/2012/Smartphone-Update-2012/Findings.aspx>.

Symantec Report Finds Cyber Threats Skyrocket in Volume and Sophistication. *Symantec*. Symantec.com, 5 Apr. 2011. Web. 8 Jan. 2012. <http://www.symantec.com/about/news/release/article.jsp?prid=20110404_03>.

Wagner, Alex. "Number of U.S. Smartphone Subscribers Surpasses 100 Million, Says ComScore." *Phonedog.com*. 18 Mar. 2012. Web. 26 Mar. 2012. <http://www.phonedog.com/2012/3/8/number-of-u-s-smartphone-subscribers-surpasses-100-million-says-comscore/>.

"What Is A Smartphone." *My Affiliate Place*. Web. 12 Feb. 2012. <http://www.myaffiliateplace.biz/Affiliate-Info-SmartPhone.htm>.

ACADEMIC VITA
Jeffrey M. Dean

Jeffrey M. Dean
345 West Nittany Avenue
State College, PA 16801
jdean569@gmail.com

Education: Bachelor of Science Degree in Security and Risk Analysis, Spring 2012
Honors in Information Sciences and Technology
Thesis Title: A STUDY OF PERCEPTIONS AND BEHAVIORS RELATED TO SMARTPHONES AND NETWORKS
Thesis Supervisor: Anna Squicciarini

Related Experience:

Information Security Internship
ISPA Technology
Summer 2010

Learning Assistant
College of Information Sciences and Technology
Classes: SRA 221, IST 456

Awards:

Dean's List	Academic Years 2008, 2009, 2010, 2011
Riddell Trustee Scholarship	Academic Years 2008, 2009
Academic Competitiveness Grant	Academic Years 2008, 2009
Internal Scholarship – IST	Academic Year 2010
PNC Technologies Scholarship Fund	Academic Year 2011