FACTOR ANALYSIS OF CUSTOMER PREFERENCE FOR MOBILE PHONE NETWORK

(A CASE STUDY OF CAPE COAST POLYTECHNIC)

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN STATISTICS.

SEPTEMBER, 2015

DECLARATION

Candidate's Declaration

This is to certify that, this thesis is the result of my own research work and no part of it has been presented for another degree in this University or elsewhere.

……………………………… ………………………………

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Supervisors' Declaration

We hereby certify that this thesis was prepared from the candidate's own research work and supervised in accordance with guidelines on supervision of thesis laid down by the University of Ghana, Legon.

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ABSTRACT

This research tries to determine the “hidden” factors which ultimately influence the choice of mobile phone network in Cape Coast Polytechnic (study area). Principal Component method of Factor analysis is used to achieve the set objectives. There are six mobile phone network providers (MTN, Vodafone, Tigo, Airtel, Globacom and Expresso) in Ghana. All these operators try to improve their marketing strategies in order to attract more customers or subscribers to increase their market share. A total of 500 respondents were drawn from students, teaching staff and administrative staff in Cape Coast Polytechnic by proportional allocation. There is no restriction in age and gender but it is required that a respondent belongs to one of these three groups. The study made use of research instrument in order to measure attributes of the networks. A 14 item likert scale was used with 5 levels of agreement in the questionnaire. The study shows that more male respondents participated in the study mostly are in the age group of 18-24 years old. Cronbach’s alpha shows that the data collected is consistent (reliable), while the Kaiser Meyer Olkin test and Bartlett’s test of sphericity show significant results that factor analysis is appropriate in the data gathered. Therefore, factor analysis is applicable. It is found that “long time usage” is the most important attribute followed by “wider coverage” and “good advert”. Surprisingly, “lower tariff” and “games of chance” happened to be the less important attributes. The most regularly used mobile phone network in Cape Coast Polytechnic is MTN followed by Tigo. Vodafone is the third most regularly used network, while Expresso is the least patronized network. Three factors were extracted, factor one is social responsibility factor (or customer care factor), factor two is reception benefit factor and factor three is relationship benefit factor. These three (3) factors identified, best summarizes the people’s choice of mobile phone network in Cape Coast Polytechnic.

DEDICATION

I dedicate this thesis to the Almighty God for His grace, protection and guidance.

Also, to my parents, Opanyin Kwaw Badu and Madam Ama Ayipeh (all of blessed memory) and my son, Yaw Atta Mensah.

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TABLE OF CONTENTS

CONTENTS **PAGES**

Declaration i

Abstract ii

Dedication iii

Acknowledgement iv

Table of Contents v

List of Tables viii

List of Figures ix

List of Abbreviations x

CHAPTER ONE

1.0 Introduction 1

1.1 Purpose of the study 5

1.2 Research Questions 5

1.3 Data Collection Procedure 6

1.4 Outline of the Thesis 8

CHAPTER TWO - LITERATURE REVIEW

2.0 Introduction 11

2.1 Evolution of Telecommunication 11

2.2 Ghana's Telecommunication 16

CHAPTER THREE - REVIEW OF METHODS

3.0 Introduction 19

3.1 Factor Analysis 19

3.1.1 Factor Analysis Model 20

3.2 The Principal Component Solution of Factor Model 23

3.3 Determining Suitable Sample Size 25

3.4 Test for Internal Reliability (or consistency) 27

3.5 The Minimum Standard Test for Factor Analysis 27

3.5.1 Bartlett's Test of Sphericity 27

3.5.2 Kaiser-Meyer-Olkin (KMO) Test of Sampling Adequacy 29

3.6 Number of Factors to Extract 30

3.6.1 Determination Based on Eigenvalues 30

3.6.2 Determination Based on Scree Plot 30

3.6.3 Significance Test of Eigenvalues 31

3.7 Test of Goodness-of-Fit of the Factor Model 31

3.8 Rotation Factor Solution 34

3.8.1 Varimax Rotation 36

3.9 Estimating Factor Score 37

3.9.1 Interpretation of Estimated Factor Score 38

CHAPTER FOUR - ANALYSIS AND RESULTS OF THE RESEARCH

4.0 Introduction 40

A. Preliminary Analysis 40

4.1 Distribution of Age and Gender 41

4.2 The Mean and Standard Deviation of the Mobile Phone Attributes 42

4.3 Usage of Mobile Phone Network 43

4.4 Bar Charts of the Mobile Phone Attributes 46

4.5 Correlation Matrix of the variables (mobile phone attributes) 60

4.6 Test of Reliability (or consistency).. 62

4.7 Kaiser-Meyer-Olkin (KMO) Test and Bartlett's test 62

B. Further Analysis 63

4.8 Number of Factors to Extract 63

4.8.1 Use of Eigenvalue Analysis 63

4.8.2 Scree Plot 65

4.9 Reproduce Correlation Matrix 66

4.10 Un-rotated Factor (Component) Matrix.. 67

4.11 Varimax Rotated Factor (Component) Matrix.. 68

4.11.1 Factor Rotation 69

4.11.2 Final Factor Solution.. 71

4.12 Estimating Factor Score.. 71

CHAPTER FIVE - SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction.. 73

5.1 Summary of Findings... 73

5.2 Discussion of Findings.. 74

5.3 Conclusion and Recommendations 77

References 79

Appendices... 83

LIST OF TABLES

Table 4.1: Distribution of Age and Gender of the Respondents 41

Table 4.2: Mean and Standard Deviation of the Mobile Phone Attributes 42

Table 4.3: Usage of Mobile Phone Network 43

Table 4.4: Usage of Mobile Phone Network by respondents in Percentage 43

Table 4.5: Correlation Matrix 60

Table 4.6: Test of Internal Reliability (Consistency).. 62

Table 4.7: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test 62

Table 4.8: Total Variance Explained 64

Table 4.9: Reproduce Correlation Matrix 66

Table 4.10: Un-rotated Component Matrix 67

Table 4.11: Varimax Rotated Component Matrix 68

LIST OF FIGURES

Figure 1: Distribution of Wider Coverage of Mobile Phone Network 46

Figure 2: Distribution of Reliable Network 47

Figure 3: Distribution of lower tariff of a Network 48

Figure 4: Distribution of Frequent Promotions and Motivation Packages of Mobile Phone Network 49

Figure 5: Distribution of Close Relations (eg. Friends, Family) who use same Network 50

Figure 6: Distribution of Fast Internet Speed 51

Figure 7: Distribution of Cheaper Starter Pack 52

Figure 8: Distribution of Strong Area Network 53

Figure 9: Distribution of Mobile Phone Banking Services.. 54

Figure 10: Distribution of Games of Chance of Mobile Phone Network 55

Figure 11: Distribution of the Network has Good Advert 56

Figure 12: Distribution of Regular Sponsorship of National Events 57

Figure 13: Distribution of Charity Work of the Network Operators 58

Figure 14: Distribution of Long Time Usage of a Network 59

Figure 15: Scree Plot of Eigenvalues and Components 65

LIST OF ABBREVIATIONS

AT&T	-	American Telephone and Telegraph
ATM	-	Automated Teller Machine
C.E.Os	-	Chief Executive Officers
HSPA	-	High Speed Packet Access
I.C.T	-	Information Communication Technology
IP	-	Internet Protocol
KMO	-	Kaiser-Meyer-Olkin
MTN	-	Mobile Telecommunication Network
NCA	-	National Communication Authority
SPSS	-	Statistical Package for Social Science
TAT-1	-	First Transatlantic Telegraph Cable
VoIP	-	Voice over Internet Protocol
Wi-Fi	-	Wireless Fidelit

CHAPTER ONE

1.0 INTRODUCTION

Telecommunication (communication by telephone) is the transmission of information from one point to another by electrical and electronic means. It can also be defined as any transmission or reception of signs, signals, writings, images, sounds and other forms in which intelligence can be presented by means other than human transport and presentation. This means telecommunication has taken over other means of communication- face to face delivery of information and letter writing.

Early Telecommunication began with the use of smoke signals and drums. Talking drums were used by natives in Africa, New Guinea and South America, and smoke signals in the North America and China. These systems were often used to do more than merely to announce the presence of a military camp **(**Baker & Burton, 2000).

The 21st century has seen massive development in telephony. Internet Protocol (IP) telephony also known as Internet Telephony or Voice over Internet Protocol (VoIP), is a disruptive technology that is rapidly gaining grounds against traditional telephone network. These new developments in telecommunication seek to address the communication problems of businesses and Government operations as well as individuals.

In Ghana, it is believed that total number of mobile phones is more than the human population, this is due to multiple subscription (Daily Graphic, November 15, 2013). This suggests that telephone communication has become one of the necessities of life after food, shelter, and clothing.

It is estimated that over 6.9 billion customers worldwide use mobile phones and in Ghana, mobile phone subscribers amounted to 26,336,000 distributed among the six mobile phone network providers - MTN, Tigo, Vodafone, Airtel, Expresso and Glo (Akakpo, 2008). This telecommunication industry covers an immense assortment of technologies that send information over long distances. The sector, relate to businesses which provide these technical services. The mobile phone, satellites technology, the internet and telephony, are at the centre of the telecommunications sector. The sector now covers:

1. Mobile phone operators (i.e. Vodafone, MTN, Tigo, Expresso, Airtel and Glo)
2. Message communication services (e–mail, Facebook, YouTube and Twitter)
3. Distributors of cable and pay television (e.g. virgin media, sky)
4. Manufacturers of accessories such as earphones, adaptors, cables, and Bluetooth products and accessories.

The competition in telecommunication industry (mobile phone network provider) is now very keen. In Ghana, all the providers are putting in new strategies in order to have the largest market share.

Some of these strategies or innovations are:

1. Increasing their coverage area.
2. Making their network reliable and affordable.
3. Making frequent promotions.
4. Providing banking services through mobile phones/telephony.
5. Organizing game of chance (lottery)

Studies have revealed that social activities and the travel demand, will be influenced by the use of new Information and Communication Technologies (I.C.Ts) such as the Internet.

These I.C.Ts offer new ways of communication, these alternatives for face-to-face communication have raised speculations about the consequence of I.C.Ts for social interactions (Miller, 1980).

Price Waterhouse Coopers (2009) report from 23 countries revealed that disruptive change is a constant feature of the communication industry and results from this survey showed that communication C.E.Os see little sign of the pace and scale of change diminishing in the future. It is surprising that 36% of communication C.E.Os is planning to make fundamental strategic changes. They were also anxious about the security of their supply chains and a significant proportion (19%) believe that lack of basic infrastructure in some markets is likely to be a serious problem for their business. The report also revealed that communication C.E.Os who are not at all confident of being able to deliver growth is noticeably higher (14%).

Research indicates that the implications of the internet and the mobile phone are complex and dependent on the type of activity, persons involved, technologies and socio–physical context in which they are embedded (Miller, 1980).

Choo and Mokhtarian (2006) in their study of Telecommunications and travel demand and supply showed an empirical result which strongly support the hypothesis that telecommunications and travel are complementary. That is, as telecommunication demand increases, travel demand increases, and vice versa.

Ren and Kwan (2008) found that the impact of internet activities on people’s activity-travel patterns are significantly different across gender. In general, internet use for maintenance purposes has a greater impact on women's activity-travel in the physical world, while internet use for leisure purposes affects men's physical activities and travel to a greater extent.

The effort being made by the six mobile phone operators to make telecommunication (telephone communication) affordable, reliable and faster is an indication that the companies are aware of the other needs of the society in general than just making and receiving a call. These are the expectations of the mobile phone subscribers. The mobile phone operators- MTN, Vodafone, Tigo, Airtel, Glo and Expresso in the Ghanaian market have the potential of throwing the consuming public in a maze of choice making.

It is believed that mobile phone network subscribers consider some underlying (latent) factors before making a choice. These underlying (latent or hidden) factors can be determined by a multivariate statistical technique known as factor analysis. Hence the topic, *"Factor Analysis of Customer's Preference for Mobile Phone Network''.*

Factor analysis is a statistical technique used to describe the covariance relationships among many variables (mobile phone attributes) in terms of a few underlying or unobserved random quantities called factors (Rommel, 1970). In this research, factor analysis is performed using principal component (pc) method of factoring. Principal component (pc) is a statistical procedure used to form new variables (underlying or latent factors) which are linear combinations of original variables (mobile phone network attributes). In principal component method of factoring the maximum number of unobserved or new variables (latent or underlying factors) that can be formed is less or equal to the number of observed or original variables (mobile phone attributes).

1.1 PURPOSE OF THE STUDY

The purpose of this study is to:

1. Compile the ratings of some attributes of some mobile phone network providers by some sections of Cape Coast Polytechnic population.
2. Identify the correlations that exist between these attributes of mobile phone network.
3. Use factor analysis to evaluate these ratings in order to determine the main underlying (latent) factors that influence one's (subscriber's) choice of mobile phone network.

1.2 RESEARCH QUESTIONS

In this research, customer's preference for mobile phone network may be defined as the conscious effort to make certain expenditure choices based on convictions about a particular network. Such personal convictions may be influenced by a number of conditions such as:

1. Are the six mobile phone operators on the market equally good?
2. Does the selected network have the desired qualities (factors) because of the rapid change over from one network to other?
3. Does the network operator provide the customers telecommunication needs and expectation?
4. Do the subscribers want the kind of reward schemes that the network operators provide?
5. Do the network operators provide the type of products and services that the subscribers expect? (eg. Mobile TV, ability to use phone for monetary transactions).

These sources of influence on choice of mobile phone network raises a major question which must be answered; "what major (latent or underlying) factors ultimately influence the choice of a mobile phone network''.

1.3 DATA COLLECTION PROCEDURE

To achieve the objectives set out in the previous sections a survey of 500 respondents comprising students, lecturers and administrative staffs were selected by use of proportional allocation. This was done to ensure homogeneity within stratum, so that any group of members selected from the stratum is a good representation of the entire population. It is expected that the results of the analysis of opinions from these samples (strata) on almost all the variables (mobile phone attributes) defined below in the study would show the attitude of mobile phone network subscribers. In this study, the respondents were asked to indicate their opinion on fourteen attributes of their stated most used mobile phone network–MTN, Vodafone, Tigo, Airtel, Expresso and Glo. The selected attributes of mobile phone network are:

X_1......................................wider coverage

X_2......................................network reliable

X_3......................................lower tariff

X_4......................................frequent promotion/rewarding/motivations

X_5......................................close relations (eg. friends or family) use same network

X_6......................................fast internet speed

X_7......................................cheaper starter pack (chip)

X_8......................................strong network in one's area

X_9......................................mobile phone banking services

X_{10}......................................frequently organize games of chance

X_{11}......................................has good advert

X_{12}......................................regular sponsorship of national events (eg. football)

X_{13}......................................encouraging charity work

X_{14}......................................used for a long time

In this research, respondents were asked to indicate the level of importance attached to each of the following indicators by use of questionnaire. The following five point's rating scale was used:

1. Strongly disagree
2. Disagree
3. Undecided
4. Agree
5. Strongly agree

In the questionnaire, a respondent indicating 4 or 5 against a variable suggests that the person really pays much attention to that attribute (variable), 1 or 2 indicates that the person does not attach much importance to the attributes and finally 3 indicates that the attributes in question at times enjoy some level of importance when choosing a mobile phone network.

Factor analysis (the main tool used in this research) is a statistical technique that is used for data reduction and summarization. In this procedure a large number of variables (mobile phone attributes) most of which are correlated is reduced to a manageable level. Factor analysis attempts to explain the correlation between the observations in terms of the underlying (latent) factors which are not directly observable. Factor analysis closely resembles principal components analysis (Cattell, 1966). Both techniques use linear combinations of variables to explain sets of observations on many variables. The combination of variables is a tool for simplifying the interpretation of the observed variables. In factor analysis, the intrinsic interest is in the "underlying factors" or "hidden factors" (latent or unobservable variables called factors). Linear combinations are formed to derive the latent or "hidden factors". The observed variables (mobile phone attributes) are relatively of little interest.

The objective in factor analysis method is to identify few factors out of the lot that seek to explain the variation in the original data set. These latent factors would be responsible in explaining the attitude of the subscribers in the population when it comes to the selection of a mobile phone network.

Cape Coast Polytechnic, used as a case study, is a tertiary institution in Cape Coast, the capital of the Central Region of Ghana. The institution is located at north–eastern part of the metropolis. It has a total population of $N = 3284$ made up of students $N_1 = 2884$, teaching staff $N_2 = 102$ and administrative staff $N_3 = 298$. Cape Coast Polytechnic is strategic because in each stratum (group) every unit uses mobile phone.

1.4 OUTLINE OF THE THESIS

In this section, we outline the content within each of the five chapters of the thesis.

The first chapter of this thesis is the introduction which covers the background to the study, its objective, research questions, sources of data and data collection procedures and design. In the background study, the history of stages of innovational efforts made by the scientists to make telephone communication faster and at every place of human habitat to satisfy the consuming public is given. It is then followed by the statement of the purpose of the study. This subsection attempts to justify and explain the need for the choice of the research topic.

Moreover, the statistical tool (factor analysis) that was used to analyze the data is explained. Next on the list in the introduction is the statement of the research questions, sources of data and data collection procedure. It considers how data was generated and its scope. This sub-section discusses the choice of the study site and states the conditions under which findings of the study are most relevant. Outline of the thesis is the last section under introduction and it gives a brief overview of the content of the study.

Chapter two covers literature review. It discusses the studies and discoveries made so far in telecommunication and the findings that have emerged. The history in telecommunication is also considered.

Chapter three reviews the important methods used in the analysis of the data. The main method considered is factor analysis. Relevant exploratory tools are used to obtain an idea of the general pattern of the raw data.

Chapter four comprises of two sections, preliminary and further analysis. In exploring the data, relevant pictorial representation (bar graph) and basic summary statistics - mean, standard deviation and correlation matrix (Preliminary analysis) were used. In this same chapter, factor analysis (Further analysis) is used to extract the underlying (latent) factors that influence the subscribers' choice of mobile phone network. Further steps are taken to ensure that the extracted factors give the most appropriate factor solution that could be obtained for the data. These measures check the goodness-of-fit of the model obtained and the interpretation given to the factors (attributes) are most appropriates.

In Chapter five, the results of the preliminary and further analysis are discussed. The challenges that were encountered in the research process are also mentioned and discussed.

Conclusions of the analysis are reached whereby relevant recommendations as well as further research areas in telephone communication are mentioned.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

The benefit of telephone communication as compared to the face-to-face delivery of messages cannot be over emphasized – it saves time, removes travelling risk, is very fast and less expensive.

2.1 EVOLUTION OF TELECOMMUNICATION

Early telecommunication began with the use of smoke signals in North America and parts of Asia (eg. China) and talking drums by natives in Africa, New Guinea and South America. These systems were often used to do more than merely to announce the presence of a military camp (Baker & Burton, 2000).

In 1792, a French engineer, Claude Chappe built the first visual telegraphy (Semaphore) system between Lille and Paris. This was followed by a line from Strasbourg to Paris. In 1794, a Swedish engineer, Abraham Edelcrantz built a quite different system from Stockholm to Drottingholm. As opposed to Chappe's system which involved pulleys rotating beams of wood, Edelcrantz system relied only upon shutters and was therefore faster. However, Semaphores as a communication system suffered from the need for skilled operators and expensive towers often at intervals of only ten to thirty kilometres. As a result, the last commercial line was abandoned in 1880, see (Arthur, 1906).

A very early experiment in electrical telegraphy was an "electrochemical" telegraphy created by a German inventor Samuel Thomas Von Sommerring in 1809, based on an earlier less robust design of 1804 by Spanish polymath and Scientist Francisco Salva Campillo (Jones and Sommerings, 1965). Their design used multiple wires (up to 35) in order to visually represent almost all Latin letters and numerals. Thus messages could be conveyed electrically up to a few kilometres with each of the telegraph receiver's wires immersed in a separate glass tube of acid. An electrical current was sequentially applied by the sender through the various wires representing each digit of message at the recipient end. The current electrolyzed the acid in the tubes in sequence, releasing streams of hydrogen bubbles next to each associated letter or numeral. The telegraph receiver's operator would visually observe the bubbles and then record the transmitted message (Jones & Sommerings, 1965).

The first successful transatlantic telegraph cable (TAT-1) was completed on July 27, 1866, allowing transatlantic telecommunication for the first time, this international use of the telegraph has sometimes been dubbed the "Victorian Internet" (Dibner, 1959).

The first commercial telephone services were set up in 1874 and 1879 on both sides of the Atlantic in the cities of New Haven and London (Arthur, 1906). Alexander Graham Bell held the master patent for telephone that was needed for such services in both countries. The technology grew quickly from this point with inter-city lines being built and telephone exchanges in every major city of the United States by the mid-1880s (Coe and Lewis, 1995). For a short period of time acoustic telephones were marketed commercially as a niche competitor to the electrical telephone, as they preceded the latter's invention and didn't fall within the scope of its patent protection. When Alexander Graham began competing for customers, acoustic telephone makers quickly went out of business (Kolger & Jon, 1986).

During the second half of the 19th century inventors tried to find ways of sending multiple telegraph messages simultaneously over a single telegraph wire by using different modulated audio frequencies for each message. These inventors included Charles Bourseul, Thomas Edison, Elisha Gray, and Alexander Graham Bell. Their efforts to develop acoustic telegraphy in order to significantly reduce the cost of telegraph messages led directly to the invention of the telephone called the ‘Speaking telegraph’ (Daniel & McVeigh, 2013).

Credit for the invention of electric telephone is frequently disputed and new controversies over the issue have arisen from time-to-time. Charles Boursel, Antonio Meucci, Johann Philip Resis, Alexander Graham Bell and Elisha Gray, amongst others, have all been credited with telephone’s invention (Coe & Lewis, 1995).

Evenson and Edward (2000) considered the question of whether Bell and Gray invented the telephone independently, and if not whether Bell stole the invention from Gray. This controversy is narrower than the broader question of who deserves credit for inventing the telephone, for which there are several claimants (Evenson & Edward, 2000).

The first commercial telephone exchange in the world was opened at New Haven, Connecticut, with 21 subscribers on January 28, 1878 (Huurdeman & Anton, 2003). A telephone exchange is a telephone system located at service centres, central offices responsible for a small geographical area that provided the switching or interconnection of two or more individual subscriber lines for calls made between them, rather than requiring direct lines between subscriber stations. This made it possible for subscribers to call each other at homes, business and public places. These made telephony an available and comfortable communication tool for everyday use, and it gave the impetus for the creation of a whole new industrial sector.

The history of mobile to two-way radio permanently installed in vehicles such as taxi cabs, police cruisers, railroad trains, and the like. Later versions such as the so called transportable or ‘bag phones’ were equipped with a cigarette lighter plug so that they could also be carried, and thus could be used as either mobile two-way radio or as portable phones by being patched into the telephone network.

In December 1947, Bell laboratory engineers Douglas H. Ring and W. Rae Young proposed hexagonal cell transmissions for mobile phones (Richard & John, 2010), (Wheen & Andrew, 2011). The technology did not exist then and the radio frequencies had not yet been allocated. Cellular technology was undeveloped until the 1960s, when Richard H. Frenkiel and Dr. Joel Engel of Bell Laboratory developed the electronic (Wheen & Andrew, 2011).

On April 3, 1973 motorola manager Martin Cooper placed a cellular phone call (in front of reporters) to Dr. Joel Engel, head of research at American Telephone and Telegraph (AT & T’s) Bell Laboratory (Wheen & Andrew, 2011). This began the era of the handheld cellular mobile phone. Meanwhile the 1956 inauguration of TAT-1 cable and later international direct dialing were important steps in knitting together the various continental telephone networks into a global network.

Internet Protocol (I.P) which uses a broadband internet service to transmit conversations as data packets also competes with mobile phone networks offering free or lower cost service via Wireless Fidelity (Wi-Fi) hotspots. Modern telecommunication also used Voice over

Internet Protocol (VoIP) which is used on private wireless networks which may or may not have a connection to the outside telephone network.

Globally, mobile subscriptions (including multiple subscriptions) are expected to reach 6.9 billion in 2013. The top mobile operator worldwide in terms of connections is China mobile, followed by Vodafone group (Akakpo, 2008). It has been projected that, 2013 and 2014 will see a positive growth in mobile phone infrastructure expenditure as carriers are forced to improve and deploy new network to cope with demand. Also by 2017 around 45% of mobile traffic is expected to be offloaded from Wireless Fidelity (Wi-Fi) (Akakpo, 2008).

Moreover, the cost of acquiring a customer has grown along with the increase in smart phone uptake. Subsidizing handset is an expensive exercise and it has become even more important for telecommunication companies to retain the customer once they are on board. In addition, lowering roaming charges also encourages goodwill at both a regulatory and consumer level and lessons the chance of bill-shock. To improve the customer experience, it is essential that the service and available data information is of the highest possible quality and real time processing development can assist with this. There is currently a lack of high customer expectation in telecommunication market as a whole – and much can be done to improve this situation.

Price Waterhouse Coopers (2009) reported that, many communication's CEOs are reconsidering how best to manage innovation, they are repositioning their portfolios to focus on developing new products and services and fine tuning existing products and services. But 60% intend to adopt new business models in response to a fast-changing environment. 75% of CEOs think talking to the customers who buy their product and services would be the best of their time. Predictably, perhaps, communication CEOs are pinning their hopes for future growth on emerging markets rather than the developed market-as indeed are their peers in other sectors. And while most CEOs with plans to expand abroad are focusing on China, 26% of communication CEOs prefer Brazil since they believe it will be a key growth market.

2.2 GHANA'S TELECOMUNICATION

Telecommunication is one of the main economic sector of Ghana, due to the Ghana liberal policy around Information and Communications Technology (ICT) (World Bank, 2013). World Bank (2013) reported that, the main sector of investment in Ghana are 65% is for ICT, 8% for communication and 27% is divided for public administration. Ghana's telecommunication statistics indicated that as of 2012, there were 284,981 telephone lines (landlines) in operation and as of 2013, there were 26,336,000 cell phone lines in operation which is more than the country's population at the time, this is due to multiple subscriptions.

Since launching the first cellular mobile network in Sub-Saharan Africa in 1992, Ghana has become one of the continent's most vibrant mobile markets with now six (6) competing mobile phone operators including regional heavy weights such as Mobile Telecommunication Network (MTN), Vodafone, Millicom (Tigo), Bharti Airtel (formerly, Zain) and Expresso (formerly, Kasapa). The entry of Nigeria's Globacom (Glo) as the sixth player in 2012 delivered another boost to the telecommunication sector.

Ghana has one of the most competitive telecommunication markets in the sub region and was a pioneer in developing mobile telephony and data service. It was also among the first on the continent to connect to the internet (Akakpo, 2008).

According to National Communication Authority's (NCA's) homepage (2012), the market share of the service providers are MTN (45.8%), Vodafone (20.53%), Tigo (14.44%), Airtel (12.46%), Globacom (6.12%) and Expresso (0.65%).

Ansah et al. (2013) in their study of prediction of subscribers' brand switching behaviour and ergodic market share of network service providers in Ghana reveals that the three most preferred operators are MTN (64.9%), Tigo (38.0%) and Vodafone (37.7%).

Low user penetration in the early part of the century was largely due to the high cost of service coupled with unreliable networks and a poor quality of service. In recent years lower pricing has filtered down well to consumers with Ghana Telecom being one of several operators which have invested in national networks to extend broadband availability deeper into rural areas (Akakpo, 2008). The mobile market is well served by six competing players. Services based on High Speed Packet Access (HSPA) technology have helped extend broadband availability. This has improved the growth potential of m-commerce and m-banking services. MTN Ghana's mobile money service is very popular, complimented by its new "ATM cash out" services. The launch of mobile number portability in mid-2011 has also been a catalyst for competition between players with the number of portings by mid-2013 having increased by 21% year-on-year. As at 2013 the telecommunication penetration by services in Ghana stands at 17% for internet, 112% for mobile telephony and 1.2% for fixed-line telephony. This indicates that competition among mobile phone companies in Ghana is an important part of the telecommunications industry growth of Ghana with companies obtaining more than 80 per 100 persons as mobile phone and fixed phone users (Akakpo, 2008).

On November 26, 2013, Daily Graphic reported an introduction of a new service, 'Triple play' which provides telephony, internet and television in a single box into the Ghanaian market and subsequently to other African countries. The service "Triple play" which will be introduced by K3 Telecom AG (a Swiss telecommunication company) will make it possible for consumers to have these three services (Telephony, Internet, Television) at a go, once they have purchased the box. This suggests that in the years ahead, consumers must expect new technological advancement in the telecommunication industry.

CHAPTER THREE

REVIEW OF METHODS

3.0 INTRODUCTION

This chapter reviews the theories and methods that relate to the main analysis of the data. Data in this research are multivariate in nature because the variables (mobile phone attributes) considered are more than two. In this research factor analysis as a multivariate statistical technique was used to analyze the data.

3.1 FACTOR ANALYSIS

Factor analysis is a statistical technique that is used for data reduction and summarization. It is used to describe, if possible the covariance relationships among many variables (mobile phone attributes) in terms of a few underlying, but unobserved random quantities called factors. The fourteen (14) mobile phone attributes (observed variables) will be reduced to smaller number of unobserved variables called factors.

In this research, the fourteen mobile phone attributes (variables) most of which are correlated is reduced to manageable level using factor analysis. In many scientific fields, particularly behavioural and social sciences, variables such as “intelligence” or “leadership quality” cannot be measured directly. Such variables, called “latent” variables, can be measured by other “quantifiable” variables, which reflect the underlying variables of interest.

Factor analysis used in this study, attempts to explain the correlation between the observations (attributes) in terms of the underlying (latent) factors which are not directly observable. This statistical technique (factor analysis) was originally developed to explain student performance in various courses and to understand the link between grades and intelligence.

Spearman (1909) hypothesized that a student performance in various courses are inter-correlated and their inter-correlations could be explained by a single latent factor of student's general intellectual ability and a second set of factors reflecting the unique qualities of the individual courses.

Factor analysis closely resembles principal component analysis. Both techniques use linear combinations of variables (attributes) to explain sets of observations on many variables. Thus, factor analysis is carried out in this research using principal component method of factoring. The combination of variables (underlying factors) is a tool for simplifying the interpretation of the observed variables (mobile phone attributes). The linear combinations of the observed variables (mobile phone attributes) are formed to derive the underlying (latent) factors. In factor analysis, the main interest is in the "factors" or "latent factors" of the observed variables (mobile phone attributes). The observed variables are relatively of little interest.

3.1.1 Factor analysis model

In orthogonal factor model, the observable (mobile phone attributes) random vector $\mathbf{X}$ with p components has mean μ and covariance matrix $\mathbf{\Sigma}$. The factor model postulates that $\mathbf{X}$ is linearly dependent upon a few unobservable (latent) random variables $f_1, f_2, ..., f_m$ called common factors and p additional sources of variation $\varepsilon_1, \varepsilon_2, ..., \varepsilon_p$ called errors or specific factors.

In particular, the factor analysis model is given as:

$$X_1 - \mu_1 = l_{11} f_1 + l_{12} f_2 + \ldots + l_{1m} f_m + \varepsilon_1$$

$$X_2 - \mu_2 = l_{21} f_1 + l_{22} f_2 + \ldots + l_{2m} f_m + \varepsilon_2$$

$$\begin{matrix} . & . & . \\ . & . & . \\ . & . & . \end{matrix}$$

$$X_p - \mu_p = l_{p1} f_1 + l_{p2} f_2 + \ldots + l_{pm} f_m + \varepsilon_p$$

where $p =$ *number of mobile phone attributes.*

$m = 1, 2, \ldots$ factors, $m \le p$

l = factor loadings (correlation between the factors and mobile phone attributes)

The above expression can be represented in matrix form as:

$$\mathbf{X} - \boldsymbol{\mu} = \mathbf{LF} + \boldsymbol{\varepsilon} \qquad (3.1)$$

$$\mathbf{X} = \mathbf{LF} + \boldsymbol{\mu} + \boldsymbol{\varepsilon}$$

where $\boldsymbol{\mu} = (p \times 1)$ mean of variables (attributes)

$\mathbf{X} = (p \times 1)$ vector of the mobile phone attributes (indicator variables)

$\boldsymbol{\varepsilon} = (p \times 1)$ specific variance

$\mathbf{F} = (m \times 1)$ common factors

$\mathbf{L} = (p \times m)$ matrix of the factor loadings.

The unobservable random vectors $\mathbf{F}$ and $\boldsymbol{\varepsilon}$ are independent whereas these ***assumptions*** must be satisfied.

$E(\mathbf{F}) = 0$, $Cov(\mathbf{F}) = \mathbf{I}$ $E(\boldsymbol{\varepsilon}) = 0$, $Cov\ (\boldsymbol{\varepsilon}) = \boldsymbol{\Psi}$ where, $\boldsymbol{\Psi}$ is a diagonal matrix.

The orthogonal factor model of a covariance structure for $\mathbf{X}$ from equation (3.1) is:

$$(\mathbf{X}-\boldsymbol{\mu})(\mathbf{X}-\boldsymbol{\mu})' = (\mathbf{LF}+\boldsymbol{\varepsilon})(\mathbf{LF}+\boldsymbol{\varepsilon})'$$

$$= (\mathbf{LF}+\boldsymbol{\varepsilon})(\mathbf{LF})' + (\mathbf{LF}+\boldsymbol{\varepsilon})\boldsymbol{\varepsilon}'$$

$$= \mathbf{LF}(\mathbf{LF})' + \boldsymbol{\varepsilon}(\mathbf{LF})' + (\mathbf{LF})\boldsymbol{\varepsilon}' + \boldsymbol{\varepsilon}\boldsymbol{\varepsilon}' \qquad (3.2)$$

So that, $\boldsymbol{\Sigma} = Cov(\mathbf{X}) = E(\mathbf{X}-\boldsymbol{\mu})(\mathbf{X}-\boldsymbol{\mu})'$, taking the expectation of equation (3.2)

$$= \mathbf{L}E(\mathbf{FF}')\mathbf{L}' + E(\boldsymbol{\varepsilon}\mathbf{F}')\mathbf{L} + \mathbf{L}E(\mathbf{F}\boldsymbol{\varepsilon}') + E(\boldsymbol{\varepsilon}\boldsymbol{\varepsilon}')$$

$$= \mathbf{LL}' + \boldsymbol{\Psi} \qquad (3.3)$$

where, $\mathbf{L} = (p \times p)$ matrix of factor loadings and $\boldsymbol{\Psi} = (p \times p)$ matrix of specific variance(errors). Thus, the covariance structure for the orthogonal model is:

(i) $Cov(\mathbf{X}) = \mathbf{LL}' + \boldsymbol{\Psi}$ or $Var(x_i) = l_{i1}^2 + l_{i2}^2 + ... + l_{im}^2 + \psi$

(ii) $Cov(x_i x_k) = l_{i1}l_{k1} + ... + l_{im}l_{km}$

(iii) $Cov(\mathbf{X},\mathbf{F}) = \mathbf{L}$ or $Cov(X_i F_j) = l_{ij}$

The model $\mathbf{X}-\boldsymbol{\mu} = \mathbf{LF}+\boldsymbol{\varepsilon}$ is linear in the common factors. If the p responses of $\mathbf{X}$ mobile phone attributes are in fact, related to underlying factors but the relationship is non-linear such as $X_1 - \mu_1 = l_{11} f_1 f_2 + \varepsilon_1$, $X_2 - \mu_2 = l_{21} f_2 f_3 + \varepsilon_2$ and so on, then the covariance structure, $Cov(\mathbf{X}) = \mathbf{LL} + \boldsymbol{\Psi}$ may not be adequate.

The factor loading l_{ij} is estimated as: $l_{ij} = \dfrac{a_{ij}\sqrt{\lambda_i}}{s_i}$, where a_{ij} = weight of x_i,

s_i = the standard deviation of x_i and λ_i = the eigenvalue of x_i.

$$\sum_{i=1}^{p} \lambda_i = S_1^2 + S_2^2 + \ldots + S_p^2 \Rightarrow \sum_{i=1}^{p} \lambda_i = trace(S)$$

S_i^2 is the sample variance of x_i whereas the eigenvectors of the mobile phone attributes are estimated by equation, $(\Sigma - \lambda \mathbf{I})e = 0 \Rightarrow e'e = 1$

Thus, the first eigenvector e_1 corresponding to the first eigenvalue λ_1 is obtained as

$$(\Sigma - \lambda_1 \mathbf{I})e_1 = 0 \quad (3.4)$$

$\Rightarrow e_1' e_1 = 1$ multiplying equation (3.4) by e_1' gives $e_1'(\Sigma - \lambda_1 \mathbf{I})e_1 = 0 \Rightarrow e_1' \Sigma e_1 = \lambda_1$,

$\mathbf{I} = identity\ matrix$

The sample variance, $\text{var}(x_i) = s_i^2$ due to the specific factors is often called the uniqueness or specific variance ε_i and it is given as: $\varepsilon_i = s_i^2 - h_i^2$ or $\varepsilon_i = 1 - \sum_{i=1}^{m} l_{im}$

Communality h_i^2 is the amount of variance a mobile phone attribute shares with all other mobile phone attributes under consideration or the proportion of variance explained by the common factors. The communality denoted by h_i^2 is given by:

$$h_i^2 = l_{i1}^2 + l_{i2}^2 + \ldots + l_{im}^2 = \sum_{j=1}^{m} l_{ij}^2,$$

where $i = 1, 2, \ldots, 14$ ($number$ of mobile phone $attributes$) and m = number of factors, $m \leq i = p$

One can notice that the communality h_i^2 is the sum of squares of the factor loadings of the i^{th} mobile phone attribute on the common factors, and however, it is when m is small relative to $i = p$ (14 mobile phone attributes) that factor analysis is most useful.

3.2 THE PRINCIPAL COMPONENT SOLUTION OF FACTOR MODEL

Principal component (pc) is a statistical procedure used to form new variables (underlying factors) which are linear combinations of original variables (mobile phone attributes). The principal component (pc) method of factor analysis of the sample covariance matrix $\mathbf{S}$ is specified in terms of its eigenvalue-eigenvector pairs $(\hat{\lambda}_1, \hat{e}_1), (\hat{\lambda}_2, \hat{e}_2), \ldots, (\hat{\lambda}_p, \hat{e}_p)$. of the mobile phone attributes, where $\hat{\lambda}_1 \geq \hat{\lambda}_2 \geq \ldots \geq \hat{\lambda}_p$.

Let $m < p$ be the number of common factors. The matrix of estimated factor (coefficients) loadings l_{ij} is given as:

$$\mathbf{L} = \left(\sqrt{\hat{\lambda}_1}\,\hat{e}_1, \sqrt{\hat{\lambda}_2}\,\hat{e}_2, \ldots, \sqrt{\hat{\lambda}_p}\,\hat{e}_p\right) \qquad (3.5)$$

The estimated specific variances $\boldsymbol{\psi}$ of the mobile phone attributes are provided by the diagonal elements of the matrix $\mathbf{S} - \hat{\mathbf{L}}\hat{\mathbf{L}}'$, so that

$$\begin{bmatrix} \varepsilon_{11} & 0 & . & . & . & 0 \\ 0 & \varepsilon_{22} & 0 & . & . & 0 \\ . & 0 & . & & & . \\ . & & & . & & . \\ . & & & & . & . \\ 0 & 0 & . & . & . & \varepsilon_{pp} \end{bmatrix}$$

with $\varepsilon_i = s_{ii} - \sum_{i=1}^{14} l_{im}^2$ (3.6)

and communalities are estimated as: $h_i^2 = l_{i1}^2 + l_{i2}^2 + \ldots + l_{im}^2 = \sum_{j=1}^{m} l_{ij}^2$ but $\sum_{j=1}^{m} l_{ij}^2 = 1$

and $\varepsilon_i = 1 - h_i^2$

The principal component method of factor analysis of the sample correlation matrix $\mathbf{R}$ of the mobile phone attributes is obtained by starting with $\mathbf{R}$ in place of sample covariance matrix

$\mathbf{S}$. In principal component solution, the estimated factor loadings (coefficients) for a given factor do not change as the number of factors increases. For instance, if $m=1$, $\hat{L}=\sqrt{\hat{\lambda}_1}\,\hat{e}_1$ and if $m = 2$, $\hat{\mathbf{L}}=(\sqrt{\hat{\lambda}_1}\,\hat{e}_1, \sqrt{\hat{\lambda}_2}\,\hat{e}_2)$ where $(\hat{\lambda}_1, \hat{e}_1)$ and $(\hat{\lambda}_2, \hat{e}_2)$ are the first two eigenvalue-eigenvector pairs for sample covariance matrix $\mathbf{S}$ or sample correlation matrix $\mathbf{R}$. It can be seen that, by the definition of $\mathbf{\Psi}$ the diagonal elements of $\mathbf{S}$ are equal to the diagonal elements of $\hat{\mathbf{L}}\hat{\mathbf{L}}'+\mathbf{\Psi}$. However the off-diagonal elements of $\mathbf{S}$ are not usually reproduced by $\hat{\mathbf{L}}\hat{\mathbf{L}}'+\mathbf{\Psi}$. The number of common factors m may be determined by a priori considerations, such as by theory or the work of other researchers, the choice of m can be based on the estimated eigenvalues in much the same manner as with principal components.

3.3 DETERMINING SUITABLE SAMPLE SIZE (n_o)

Cochran (1977) proposed sample size determination formula given by:

$$n=\frac{z^2_{\alpha/2}\,p(1-p)}{d^2},$$

where $n =$ *sample size to be determined*

$p =$ *maximum possible population proportion*

$d =$ *acceptable margin of error* (5%)

$Z_{\alpha/2} =$ *value for selected* α *level of* $5\% = 1.96$

Krejcie and Morgan (1970) recommended that researchers should use $p=0.5$ as an estimate of maximum possible population proportion if the sample proportion cannot be obtained (is unknown) from a previous comparable survey. Thus, $n=\frac{(1.96)^2(0.5)(0.5)}{(0.05)^2}=384.16$

Since the sample size exceeds 5% of the population $(3284 \times 0.05 = 164.2)$, Cochran's (1977) correction formula is used to determine the final sample size, $n_0 = \frac{n}{1+\frac{n}{N}} = \frac{384}{1+\frac{384}{3284}} = 343.78$ where, $N = 3284$, $n = 384$ and n_o = final sample size to be determined.

Considering a response rate of 70%, a minimum drawn sample size of $343.78 \div 0.70 = 491.42$ is required. Thus, sample of 500 respondents were taken from the population (students, administrative staff and teaching staff). Since the respondents are in three strata (students, teaching staff and administrative staff) the selection of response unit in each stratum was determined by applying **proportional allocation** given by: $n_h = \frac{nN_h}{N}$, where $n = sample\ size$, $N = total\ population$, $N_h = population\ in\ stratum\ h$, $n_h = sample\ size\ from\ stratum\ h$ (students, teaching staff and administrative staff and $h = stratum\ number$. Thus, I represented

$n_1 - selected\ sample\ size\ from\ students$, $n_2 - selected\ sample\ size\ from\ teaching\ staff$ and $n_3 - selected\ sample\ from\ administrative\ staff$ so that $n_1 + n_2 + n_3 = n$ and $N_1 + N_2 + N_3 = N$, where n is the total sample size $(n = 500)$ and N total population $(2884 + 102 + 298) = 3284$. Therefore, $n_1 = 500 \times \frac{2884}{3284} = 439$, $n_2 = 500 \times \frac{102}{3284} = 16$ and $n_3 = 500 \times \frac{298}{3284} = 45$.

Thus, 439 respondents were selected from the students, 16 were selected from the teaching staff and 45 were selected from the administrative staff.

Non-probability sampling (a sampling technique that does not employ the rules of probability theory) - quota and convenient sampling methods were used to select 500 respondents to answer the questionnaire.

3.4 TEST OF INTERNAL RELIABILITY (OR CONSISTENCY)

Cronbach's alpha (α) is used to determine the reliability (or consistency) of the collected data. Cronbach's alpha (or reliability coefficient) is a measure of internal consistency that is how closely related a set of indicators (mobile phone attributes) are as a group. It is considered as a measure of scale reliability. A reliability coefficient (Cronbach's alpha) of 0.70 or higher is considered "acceptable" (Nunnally, 1978).

Using standardized Cronbach's alpha defined as $\alpha_{standardised} = \frac{p\bar{r}}{(1+(p-1)\bar{r})}$

where $p = number\ of\ mobile\ phone\ attributes$ and $\bar{r} = \frac{p(p-1)}{2}$ non-redundant correlation coefficients (that is the mean of upper or lower triangular correlation matrix).

3.5 THE MINIMUM STANDARD TESTS FOR FACTOR ANALYSIS

Before using factor analysis, the following minimum standard tests were applied to ascertain, if factor analysis is appropriate for the collected data

3.5.1 Bartlet's Test of Sphericity

Bartlet's test of sphericity is a test statistic that was used in this research to examine the hypothesis that the variables (mobile phone attributes) are uncorrelated in the population.

In other words, the population correlation matrix is an identity matrix; each variable correlates perfectly with itself $(r = 1)$ but has no correlation $(r = 0)$ with other variable.

Thus, if the mobile phone attributes are correlated then factor analysis can be used for the data.

The test hypothesis is;

H_o: Mobile phone attributes are uncorrelated against the alternative hypothesis

H_1: Mobile phone attributes are correlated.

The test statistic is a chi-square transformation of the correlation matrix given by,

$$\chi^2 = -2\left[1 - \frac{1}{6pm}\left(2p^2 + p + 2\right)\right] \ln L \qquad (3.7)$$

where $n = sample\ size\,(500)$, $p = number\ of\ attributes\,(14)$,

$$m = number\ of\ factors,\ m \leq p \text{ and } L = \left(\frac{\text{Geometric mean } \lambda_i}{\text{Arithmetic mean } \lambda_i}\right)^{n/2} = \left[\frac{\prod_{i=1}^{p}\lambda_i}{\frac{1}{p}\sum_{i=1}^{p}\lambda_i}\right]^{n/2}$$

$\lambda_i (i = 1, 2, \ldots 14)$ are the eigenvalues of the component factors. The test statistic has $\chi^2 - distribution$ with $\frac{1}{2}(p-1)(p+2)$ degrees of freedom. Thus, at significance level of α when the calculated χ^2 value is greater than the table $\chi^2_{\alpha,\ \frac{1}{2}(p-1)(p+2)}$ value leads to the rejection of the null hypothesis H_o. The conclusion is that:

1. The mobile phone attributes have no constant variance.
2. There are correlations among the mobile phone attributes.

On the other hand if H_o is not rejected, it means, the mobile phone attributes are not correlated or the population correlation matrix is a $(p \times p)$ unit matrix and factor analysis would not be appropriate for the data. It can be seen from equation (3.7) that the test statistic strongly depends on the sample sizes, n. That is, if n is very large, the value of $In\, L$ causes the test statistic to be large. This suggests that there exist correlations among the variables for large values of n. This makes results of the Bartlett's test, highly dependent on the sample size (Bartlett, 1954).

3.5.2 Kaiser-Meyer-Olkin (KMO) Test of Sampling Adequacy

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is an index that is used in this research to examine if factor analysis is appropriate for the data. High values $(between\ 0.5\ and\ 1.0)$ indicate that factor analysis is appropriate. In the KMO test, if the value (index) is below 0.5, it implies that factor analysis may not be appropriate for the data. The KMO index compares the magnitudes of the observed correlation coefficients with magnitudes of the partial correlation coefficients. Small values of the Kaiser-Mayer Olkin (KMO) statistic indicate that the correlations between pairs of mobile phone attributes cannot be explained by other mobile phone attributes and that factor analysis may not be appropriate for the data. Kaiser and Rice (1974) suggested the following guide for the interpretation of the KMO measure of sampling adequacy since there is no statistical test.

Kaiser's guide for interpreting KMO (Index) measure

KMO measure	***Recommendation***
≥ 0.90	marvelous
0.80+	meritorious
0.70+	middling
0.60+	mediocre
0.50+	miserable
≤ 0.50	unacceptable

It can be seen from the guide that high value of KMO is desired. They suggested that the overall KMO measure should be greater than 0.8, however, a measure above 0.60 is accepted.

3.6 NUMBER OF FACTORS TO EXTRACT

This is where the information contained in the original variables (mobile phone attributes) is summarized. Smaller number of factors (latent factors) was extracted using combination of **scree plot** and **eigenvalue greater-than-one rule.** In this method, the main aim is to look for fewer (underlying or latent) factors that could do well in explaining the maximum amount of variation in the data set.

3.6.1 Determination Based on Eigenvalues (λ_i)

An eigenvalue represents the amount of variance associated with the factors.

Zwich and Velicer (1986) suggested eigenvalue greater-than-one rule that, factors with eigenvalue greater than one contribute more in explaining the variance in the original set of variables (mobile phone attributes). In this procedure factors with eigenvalues greater than 1.0 are retained; the other factors are not included in the factor model.

3.6.2 Determination Based on Scree Plot

This method was used to confirm the determination of extracted factors by eigenvalue-greater-than-one rule. The scree plot proposed by Cattell (1966), which is also called the elbow rule is a line graph of the eigenvalues λ_i against the number of factors f_i in order of extraction. In this method the number corresponding to where the plot exhibits an elbow is taken to represent the number of factors to be extracted. Typically, the plot has a distinct break between the steep slope of factors, with large eigenvalues and a gradual trailing off associated with the rest of the factors. This gradual trailing off is referred to as the Scree. Experimental evidence indicates that the point at which the scree begins denotes the true number of factors to be extracted.

3.6.3 Significance Test of Eigenvalues.

The statistical significance of the separate eigenvalues are determined, and only those factors that are statistically significant are retained using the relation:

$$m < \frac{1}{2}\left(2p+1-\sqrt{8p+1}\right) \tag{3.8}$$

where $m = number\ of\ factors\ to\ be\ extracted$ and

$p = number\ of\ mobile\ phone\ attributes\ (14)$

The number of common factors cannot exceed the largest integer satisfying the equation (3.8) and should be greater or equal to one (Morrison, 1976).

3.7 TEST OF GOODNESS-OF-FIT OF THE FACTOR MODEL

Goodness of fit was used in this research to explain if the factor model is statistically good. Supposing m factors were extracted out of p mobile phone attributes, and denoting the loading matrix by $\mathbf{L}$ whose dimension is of $(p \times m)$.

The product $\mathbf{LL'}$ is a $(p \times p)$ reproduced matrix of the correlation matrix of the indicator variables. The diagonal elements of $\mathbf{LL'}$ are called communalities and given by $\sum_{j=1}^{m} l_{ij}$ of the mobile phone attribute x_i. If the m factors adequately approximate the correlation matrix $\mathbf{R}$, then the difference $\mathbf{R}-\mathbf{LL}'$ is a diagonal matrix. The $m-factor$ model is then said to be adequate.

Denoting this diagonal matrix by $\boldsymbol{\psi}$, then $\mathbf{R}-\mathbf{LL}'=\boldsymbol{\psi}$ where the elements of $\boldsymbol{\psi}$ are the specific variances ε_i which is equal to $\varepsilon_i = 1-\sum_{j=1}^{m} l_{ij}$. The hypothesis to be tested to determine the adequacy of the model is:

H_o : $\boldsymbol{\Sigma} = \boldsymbol{\psi} + \mathbf{LL}'$, the population covariance matrix can be estimated using m factors.

H_1 : $\boldsymbol{\Sigma}$ $, is\ any\left(p \times p\right)$ symmetric positive definite matrix.

The test statistic suggested by Bartlett (1954) is

$$\chi^2 = \left[N-1-\tfrac{1}{2}\left(2p-4m+5\right)\right] In \frac{\left|\hat{\boldsymbol{\psi}}+\hat{\mathbf{L}}\hat{\mathbf{L}}'\right|}{|\mathbf{S}|} \tag{3.9}$$

where $\hat{\psi}$ and $\hat{L}$ are the solutions of the maximum likelihood equations given as: $\frac{\delta l(\hat{L},\hat{\psi})}{\delta \psi_i} = 0$ and $\frac{\delta l(\hat{L},\hat{\psi})}{\delta l_{ij}} = 0$

the function $l(L,\psi)$ is the logarithm of the likelihood function obtained from the Wishart density given by $f(S) = C|S|^{\frac{1}{2}(n-p-1)} |\Sigma|^{-\frac{1}{2}} \exp\left(-\tfrac{1}{2} ntr\,\Sigma^{-1} s\right)$. If the null hypothesis is true, as n becomes large, the statistic becomes a χ^2 distribution with $v = \tfrac{1}{2}\left[(p-m)^2 - p - m\right]$ number degrees of freedom, where $p =$ number of rows or columns of any symmetric positive matrix and $m = number\ of\ \ common\ factors.$

At significant level of α, the null hypothesis of exactly m common factors is rejected if $\chi^2_{cal} \geq \chi^2_{table\ value}$

By invariance property of the estimated loadings and specific variances, the same value of the test statistics would be obtained from a factor solution in terms of the correlation matrix.

Lawley and Maxwell (1971) showed that the value of the determinant ratio $In\frac{|\hat{\boldsymbol{\psi}}+\hat{\mathbf{L}}\hat{\mathbf{L}}'|}{|\mathbf{S}|}$ is approximately equal to $\sum\sum_{i<j}\frac{(s_{ij}-\hat{\sigma}_{ij})^2}{\psi_i\psi_j}$, where $\hat{\sigma}_{ij}$ is the covariance of i^{th} attribute with j^{th} factor and given by:

$$\hat{\sigma}_{ij} = \sum_{j=1}^{m} l_{ij} l_{ij}\ , \quad i \neq j$$

This is the ij^{th} off diagonal element of the product matrix $\mathbf{LL}'$. Thus, the approximate test statistic is given by:

$$\chi^2 = \left[N-1-\tfrac{1}{6}(2p+4m+5)\right]\sum\sum_{i<j}\frac{\left(s_{ij}-\hat{\sigma}_{ij}\right)^2}{\psi_i\psi_j} \qquad (3.10)$$

The test statistic above has the same asymptotic chi-square distribution as in equation (3.10) but $(s_{ij}-\hat{\sigma}_{ij})$ is the ij element, $\left(res_{ij}\right)$ is the residual matrix of the $m-factor$ model. Thus, the test statistic of equation (3.10) above can be written as:

$$\chi^2 = \left[N-1-\tfrac{1}{6}(2p+4m+5)\right]\sum\sum_{i<j}\frac{res_{ij}^2}{\psi_i\psi_j} \qquad (3.11)$$

If the factor model well approximates the correlation matrix $\mathbf{R}$, the residual elements $\left(res_{ij}\right)$ are very small. A very small value of the sum of the test statistic in equation (3.11) corresponds to the decrease in value of χ^2. Thus, we fail to reject H_0, if the χ^2 value is smaller than the tabulated value $\chi^2_{\alpha,v}$. Where α is the level of significance and $v = \frac{1}{2}\left[(p-m)^2 - p - m\right]$ degrees of freedom.

Suppose $m = 0$, that is, $0-$ *factor* model then the null hypothesis is reduced to: $H_o : \mathbf{\Sigma} = \boldsymbol{\psi}$, the covariance matrix is diagonal, that means the mobile phone attributes are independent against alternative hypothesis

$H_1 : \mathbf{\Sigma} \neq \boldsymbol{\psi}$, the covariance matrix is not diagonal, that is the mobile phone attributes are not independent.

In this case the test statistic suggested by Bartlett (1954) is given as:

$$\chi^2 = -2\left[1 - \tfrac{1}{6n}(2p+11)\right] InL \qquad (3.12)$$

where $L = \frac{|\mathbf{S}|^{n/2}}{\prod_{i=1}^{p} S_{ij}^2} = |\mathbf{R}|^{n/s}$ with $\frac{1}{2}p(p-1)$ degrees of freedom.

Now, for a diagonal matrix, the determinant is the product of the diagonal elements. Thus, if $\mathbf{R}$ is the $(p \times p)$ unit matrix, then $\mathbf{R} = \mathbf{1}$, and $\ln L = 0$. Therefore, the value of χ^2 is very small if $\mathbf{R}$ is approximately equal to the unit matrix.

When equation (3.12), χ^2_{cal} is very small, then we cannot reject H_o and conclusion is that the variables are independent. Thus, factoring cannot be applied. One can notice that, test of goodness-of-fit of the factor model is similar to the test of sphericity.

3.8 ROTATION FACTOR SOLUTION

The un-rotated factor matrix indicates the relationship (correlation) between the factors and the individual mobile phone attributes. In this research, the un-rotated factor matrix is difficult to interpret, because the factors correlate with many attributes. Through rotation (varimax rotation) the complex factor matrix is transformed into a simpler matrix that is easy to interpret. In rotating the factors, we would like each factor to have non-zero, or significant loading or coefficient for only some of the fourteen mobile phone attributes. Rotation does not affect the communalities and the percentage of total variance explained, but the percentage of variance accounted for by each factor changes. Analytically the transformation of the factor matrix corresponds to a rigid rotation (or reflection) of the coordinate axes. If $\hat{\mathbf{L}}$ is the $(p \times m)$ matrix of estimated factor loadings obtained by principal component method of factoring then,

$$\hat{\mathbf{L}}^{*} = \hat{\mathbf{L}}\mathbf{T} \qquad (3.13)$$

Notice that $\mathbf{TT'} = \mathbf{T'T} = \mathbf{I}$ is a $(p \times m)$ matrix of rotated loadings.

However, the estimated covariance (or correlation) matrix remains unchanged, since

$$\hat{\mathbf{L}}\hat{\mathbf{L}} + \boldsymbol{\psi} = \hat{\mathbf{L}}\mathbf{TT'}\hat{\mathbf{L}} + \boldsymbol{\psi}$$

$$= \hat{\mathbf{L}}^{*}\hat{\mathbf{L}}^{*} + \hat{\boldsymbol{\psi}} \qquad (3.14)$$

where $\mathbf{T}$ is the transformation matrix given by:

$\mathbf{T} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$ clockwise rotation, or $\mathbf{T} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$ anticlockwise rotation, and θ, the angle of rotation.

The equation (3.14), above, indicates that the residual matrix estimated by

$\mathbf{S_n} - \hat{\mathbf{L}}\hat{\mathbf{L}}' - \boldsymbol{\psi} = \mathbf{S_n} - \hat{\mathbf{L}}^{*}\hat{\mathbf{L}}^{*\prime} - \boldsymbol{\psi}$ of the reproduced matrix, remains unchanged.

Moreover, the specific variance ε_i and the communalities $\mathbf{h_i^2}$ are not altered. The complex factor matrix is rotated to achieve a simpler structure that is easy to interpret. The varimax rotation is used (in this research) to achieve a pattern of loadings such that each variable (mobile phone attribute) loads highly on a single factor and has small-to-moderate loadings on the remaining factors (Morrison, 1976; Harman, 1976).

The new rotated loadings is determined by, $\hat{\mathbf{L}}^{*} = \hat{\mathbf{L}}\mathbf{T}$, where $\hat{\mathbf{L}}^{*} = (p \times 2)$, estimated transformation matrix of the factor loadings and $\hat{\mathbf{L}} = (p \times 2)$, estimated matrix of the factor loadings.

3.8.1 Varimax rotation.

The varimax rotation suggested by Kaiser (1958) is used in this research to obtain a simple structure of factor loadings that can easily be interpreted. The final rotated coefficients (factor loadings or correlation) is estimated by $\hat{l}^{*} = \frac{\hat{l}_{ij}^{*}}{\hat{h}_i}$ and the coefficients are scaled by the square root of the communalities. The normal varimax procedure selects the orthogonal transformation T that makes

$$v = \frac{1}{p}\sum_{j=1}^{m}\left[\sum_{i=1}^{p} l_{ij}^{*4} - \frac{\left(\sum_{i=1}^{p} l_{ij}^{*2}\right)^{2}}{P}\right] \tag{3.15}$$

as large as possible, where p is the fourteen (14) mobile phone attributes. On scaling the rotated coefficients l_{ij}^{*} has the effect of giving variables with small communalities relatively more weight in the determination of simple structure. After the transformation $\mathbf{T}$ is determined, the loadings l_{ij}^{*} are multiplied by h_i so that the original communalities are preserved.

The varimax method of factor rotation has the following properties:

1. Kaiser's (1958) maximand in the equation (3.15) above has a combined effect of equal weighting and normalization of the loadings for each attribute (variable).
2. Kaiser's varimax rotation function involves fourth powers of the loadings.
3. By considering variances of squared loadings for the columns rather than the rows of the loading matrix, varimax approach might focus more on identifying possible indicators (attributes) per factor.

3.9 ESTIMATING AND INTERPRETING FACTOR SCORE

In principal component (pc) method of factor analysis, factor score (a score for an individual on a factor) can be estimated (for each respondent) if necessary to be used instead of the original variables (mobile phone attributes) in follow-up analysis. Multiple regression method (refined method) of estimating factor score is used in this research. Mathematically, factor score is a linear combination of p mobile phone attributes (original variables). For instance, the factor score for individual i on a given factor j is represented as:

$$\hat{\mathbf{F}}_{ij} = \hat{\mathbf{B}}_1 \mathbf{X}_{i1} + \hat{\mathbf{B}}_2 \mathbf{X}_{i2} + \ldots + \hat{\mathbf{B}}_p \mathbf{X}_{ip} \qquad (3.16)$$

where $\hat{F}_{ij}$ = estimated factor score for factor j for individual i, $\hat{B}_p$ = the estimated factor score coefficient for variable (factor loading on p mobile phone attribute) and

X_{ip} = the p^{th} mobile phone attribute (observed indicator) for individual i.

Equation (3.16) is represented in matrix form as $\hat{\mathbf{F}} = \mathbf{X}\hat{\mathbf{B}}$, where

$\hat{\mathbf{F}} = (n \times m)$ matrix m factor score for the n individuals

$\hat{\mathbf{B}} = (p \times m)$ matrix of estimated factor (loadings) score coefficients

$\mathbf{X} = (n \times p)$ matrix of mobile phone attributes

The factor score coefficient for the standardized indicator variables (mobile phone attributes) are obtained from the factor score matrix when principal component (pc) method of factor analysis is used. For standardized indicators (mobile phone attributes)

$$\hat{\mathbf{F}} = \mathbf{Z}\hat{\mathbf{B}} \qquad (3.17)$$

Equation (3.17) can be written as:

$\frac{1}{n}\mathbf{Z}'\hat{\mathbf{F}} = \frac{1}{n}\mathbf{Z}'\mathbf{Z}\hat{\mathbf{B}}$ or $\mathbf{L} = \mathbf{R}\hat{\mathbf{B}}$ (when $\mathbf{R}$ correlation matrix is used) where $\mathbf{L} = \frac{1}{n}(\mathbf{Z}'\hat{\mathbf{F}})$, $\mathbf{R} = \frac{1}{n}(\mathbf{Z}'\mathbf{Z})$ and $Z_i = \frac{x_i - \mu}{\sigma}, i = 1, 2, ..., 14$ attributes. Thus, the factor score coefficient matrix is given by $\hat{\mathbf{B}} = \mathbf{R}^{-1}\mathbf{L}$ and estimated factor scores by

$$\hat{\mathbf{F}} = \mathbf{Z}\mathbf{R}^{-1}\mathbf{L} \text{ or } \hat{\mathbf{F}} = \hat{\mathbf{L}}^{*\prime}\mathbf{R}^{-1}\mathbf{Z} \qquad (3.18)$$

where $\hat{\mathbf{F}} = (m \times 1)$ row vector of m estimated factor scores, $\mathbf{R}^{-1} = (p \times p)$ inverse of the correlation matrix between the p mobile phone attributes, $\hat{\mathbf{L}}^{*} = (p \times m)$ estimated pattern matrix of loadings of p mobile phone attributes on m factors (components) and

$\mathbf{Z} =$ row vector of p standardized mobile phone attributes (Z-score of 14 mobile phone attributes).

One of the simplest ways to estimate factor scores for each individual involves summing raw scores corresponding to all mobile phone attributes loading on a factor. If a mobile phone attribute yields a negative factor loading, the raw score of the item is subtracted rather than added in the computations because the item is negatively related to the factor (Comrey & Lee, 1992).

3.9.1 Interpretation of Estimated Factor Score

Factor score is the score of each person on the underlying (latent or hidden) indicators (for instance various respondents rate the importance of the 14 mobile phone attributes). It is used to weight the variables (mobile phone attributes).

Distefano et al. (2009) in their article on Understanding and using Factor Scores: Considerations for the applied researcher pointed out that, in terms of loadings $\mathbf{L}$, positive factor score correspond to lower than average ratings (or the respondent gave higher than average importance ratings), negative factor score correspond to higher than average ratings (or respondent gave lower than average importance ratings), while zero (0) factor score correspond to close average ratings (or the respondent ratings of the importance of a relevant attributes is close to the average for the sample).

CHAPTER FOUR

ANALYSIS AND RESULTS OF THE RESEARCH

4.0 INTRODUCTION

This chapter involves analysis of the results of the study. It involves preliminary analysis (descriptive statistics- sample mean, sample standard deviation and bar graphs) and further analysis in which principal component (pc) method of factoring is used to obtain the set objectives. Statistical Package for Social Sciences (SPSS) is the software used for the analysis.

A. PRELIMINARY ANALYSIS

Data collected from the respondents are explored in this chapter to identify the nature of the variables. Through the exploration, some of the objectives and research questions would be answered. The mean and standard deviation of the attributes, age distribution, frequency distribution of mobile phone network, bar graphs of the opinion of respondents on the mobile phone attributes are used to explore the data. Bartlett's test of sphericity proposed by Bartlett (1954) as well as Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy proposed by Kaiser and Rice (1974) are used to ascertain the approprieverness of the use of factor analysis in further analysis, while Cronbach's alpha is used to test the reliability (consistency) of the data (Nunnally,1978).

4.1 DISTRIBUTION OF AGE AND GENDER

Table 4.1 shows the Age Distribution and Gender of the respondents obtained from Table A1 of Appendix II.

Table 4.1: Distribution of Age and Gender of the Respondents.

Age	Male	Female	Total	Total (%)
Under 18	15	17	32	6.4
18-24	198	114	312	62.4
25-29	60	35	95	19.0
30-39	25	17	42	8.4
Over 39	10	9	19	3.8
Total	308	192	500	100.0

Table 4.1 shows the cross tabulation of age against gender; it can be seen from the table that 308 (constituting 61.6 %) males and 192 (constituting 38.4%) females were interviewed for the study, and these comprise students, lecturers and administrative staff (from Cape Coast Polytechnic). Moreover, majority (62.4%) of the respondents were aged between 18-24 in which 39.6% were males and 22.8% were females whilst very few (3.8 per cent) of the respondents were over 39 years.

4.2 THE MEAN AND STANDARD DEVIATION OF THE MOBILE PHONE ATTRIBUTES

Table 4.2 shows the Mean and standard deviation of the mobile phone attributes obtained from Table A2 of Appendix II.

Table 4.2: Mean and Standard Deviation of the variables

Variable	Mean	Standard Deviation
X_1	3.99	1.16
X_2	3.52	1.28
X_3	3.29	1.38
X_4	3.48	1.26
X_5	3.70	1.21
X_6	3.57	1.24
X_7	3.68	1.89
X_8	3.65	1.22
X_9	3.60	1.27
X_{10}	3.22	1.28
X_{11}	3.91	1.07
X_{12}	3.62	1.19
X_{13}	3.57	1.21
X_{14}	4.19	1.05

From Table 4.2, above, the highest mean (4.19) and the lowest standard deviation value is recorded by "X_{14} (long time usage)" of the network. This means the respondents consider the "long time usage" very important since this attribute had the highest rating. It is quite likely that a customer who has used a particular network for a long time would find it difficult to change over. The next attributes have high means which are less than what we have already seen, and also enjoy considerable amount of importance attached to them. These attributes are "X_1 (wider coverage)" and "X_{11} (good advert)" with means 3.99 and 3.91 respectively.

The last set of attributes that have lowest mean values, may be important to some people, they may not be as important as those in the first and second group, since these attributes received low ratings from the respondents. These attributes are "X_3 (cheaper call cost)" and "X_{10} (games of chance)", having means 3.29 and 3.22, respectively. It is interesting that almost all the variables have means around 3 with the exception of "X_{14} (long time usage)" which has a mean of 4.19.

4.3 USAGE OF MOBILE PHONE NETWORK

This section shows the usage of the mobile phone network (MTN, Vodafone, Tigo, Airtel, Glo and Expresso) in the Cape Coast Polytechnic population. Tables 4.3 and 4.4 show the usage of the mobile phone network by the respondents, obtained from Table B1 to B6 of Appendix II.

Table 4.3: Usage of Mobile Phone Network.

	Network Operator						
Usage	MTN	Tigo	Vodafone	Airtel	Glo	Expresso	**TOTAL**
Most Regular used	281	99	35	30	19	7	**471**
Regular used	22	65	51	28	21	6	**193**
Rarely used	28	51	46	25	24	1	**175**
Not used	1	7	12	13	15	12	**60**
Not Applicable	168	278	356	404	421	474	**2101**
TOTAL	**500**	**500**	**500**	**500**	**500**	**500**	**3000**

Table 4.4: Usage of Mobile Phone Network by respondents in Percentage

	Network Operator (%)						
Usage	MTN	Tigo	Vodafone	Airtel	Glo	Expresso	**TOTAL**
Most Regular used	56.2	19.8	7.0	6.0	3.8	1.4	**94.2**
Regular used	4.4	13.0	10.2	5.6	4.2	1.2	**38.4**
Rarely used	5.6	10.2	9.2	5.0	4.8	0.2	**35.0**
Not used	0.2	1.4	2.4	2.6	3.0	2.4	**12.0**
Not Applicable	33.6	55.6	71.2	80.8	84.2	94.8	**420.4**
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**600.0**

From Tables 4.3 and 4.4 above, convincing majority (303) of the respondents (constituting 60.6% from Table B1 of Appendix II) out of 500 respondents use MTN network regularly because, most of their friends and families are using the same network, faster internet speed, wider coverage and mobile phone banking services (MTN mobile money). Moreover, 5.6% of the respondents rarely use the network and only one (0.2%) respondent said he or she does not use the network at all. Overwhelmingly, 33.6% of the respondents said they are not connected to MTN network due to unreliable network.

Moreover, the usage of Tigo (from Table B2 of Appendix II) network by Cape Coast Polytechnic population show that majority (55.6%) of the respondents are not Tigo subscribers, but 32.8% of the subscribers use the network regularly because it has faster internet speed, organize banking services called Tigo cash. But 1.2% of the Tigo subscribers have abandoned their chips. This is due to unreliable network or want to use same network with their friends and families.

Furthermore, the Vodafone usage is very surprising. The majority (71.2%, Table B3 of Appendix II) of the respondents said they are not Vodafone subscribers. But 17.2% of the subscribers use this particular network regularly. Moreover, 2.4% of the respondents who are

Vodafone subscribers are no more using the network. Their reason is to have a network that provides mobile phone banking services.

With respect to the Airtel network, overwhelming majority (80.8%, from Table B4of Appendix II) of the respondents are not subscribers. This is due to lack of reception in their area of residence and also most of their friends and families are not using same network. Though, 2.6% subscribers are not using the network but only a handful (11.6%) use the Airtel network regularly.

Besides, Glo network which has 8.0%, (Table B5 of Appendix II) of the market share in Cape Coast Polytechnic, use of the network regularly is extremely low. Surprisingly, the greater proportion 84.2% (Table B5 of Appendix II) of the respondents said they do not have interest in using the network at all because it has no wider coverage, do not operate mobile phone banking services and their friends are not using the same network. Some respondents also said that since they are already subscribers of other network, they find it difficult to change network. Three percent of the subscribers who decided to use the network have now abandoned their chips due to the reasons outlined above.

Lastly, 474 (constituting 94.8%, from Table B6 of Appendix II) out of 500 respondents are not Expresso subscribers. A very small proportion (2.6 %) of the subscribers use the network regularly, which is extremely low compared to other networks, while 2.4% of the respondents who were once users are no more using the Expresso network, the reasons given by the respondents are lack of wider coverage, it is analog, do not provide mobile phone banking services and most of their friends and families are not using the network.

4.4.3 The Bar Graph of Lower Tariff (Cheaper Call Cost)

Figure 3 shows the bar graph of the lower tariff (cheaper cost) obtained from Table C3 of Appendix II.

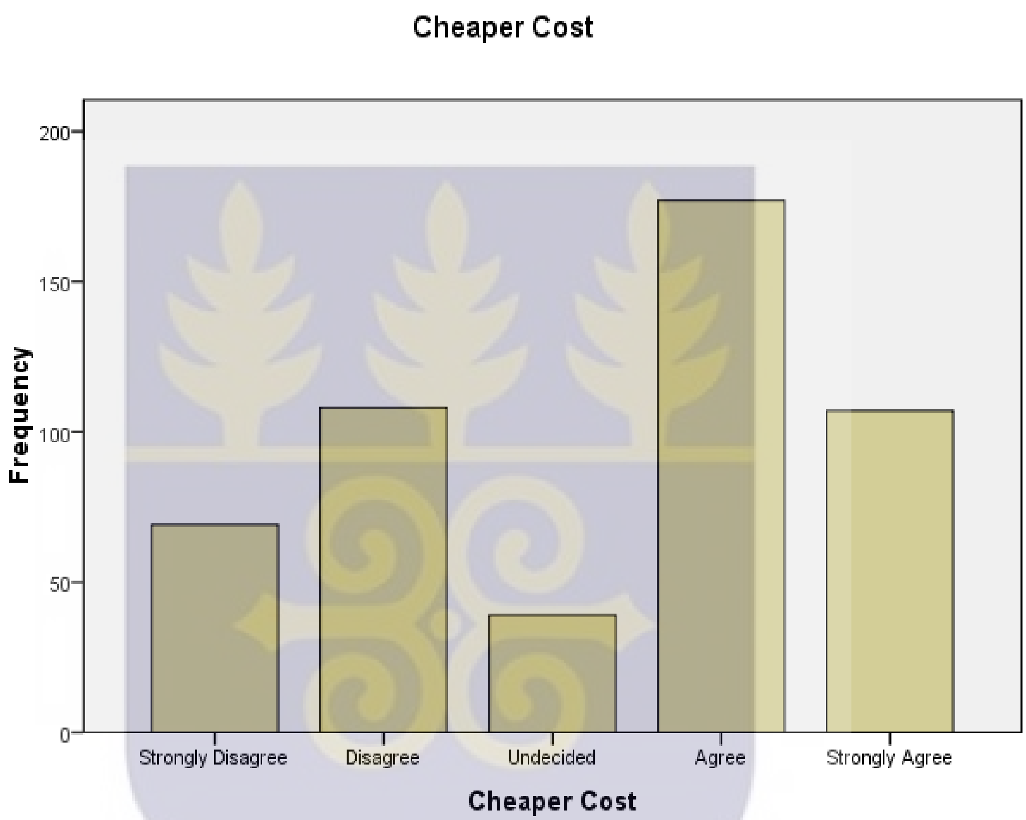

FIGURE 3: Distribution of lower tariff (cheaper cost)

From the bar graph above, most of the respondents (56.8%) agree that they would choose a network that has lower tariff. Surprisingly 35.4% of the respondents said lower tariff will not be their network attribute in selecting a mobile phone network.

4.4.4 The Bar Graph of Frequent Promotions and Motivations

Figure 4 shows the bar graph of frequent promotions and Motivation packages of mobile network (obtained from Table C4 of Appendix II).

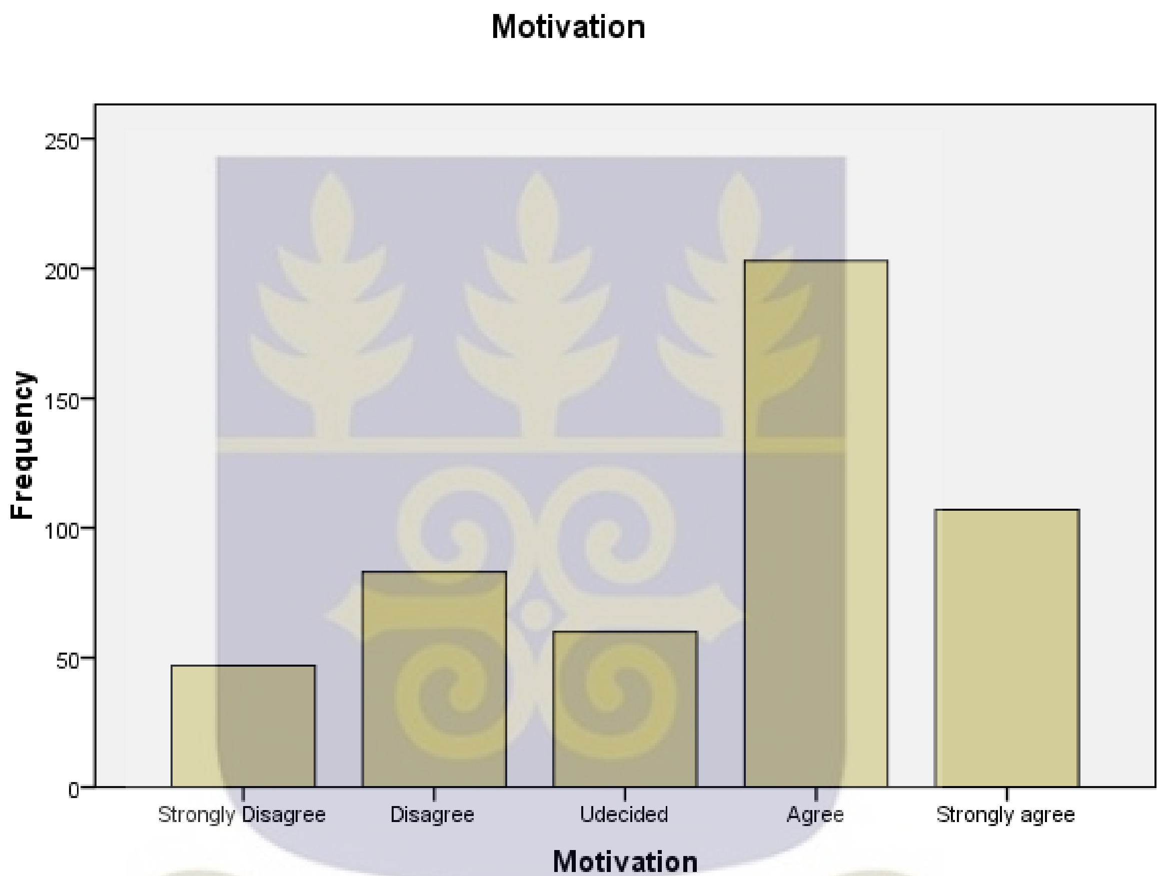

FIGURE 4: Distribution of frequent promotions and Motivation packages of mobile phone network.

From figure 4, it can be seen that the majority (62.0%) of the respondents agreed that the motivational and reward packages aspect influenced them in choosing a particular type of mobile phone network. But 26% of them said motivational aspect of the network will not lure them in selecting a network to be used.

4.4.5 The Bar Graph of Close Relations who use the same Network

Figure 5 (obtained from Table C5 of Appendix II) shows the bar graph of Close relations (eg. friends, family) who use same network.

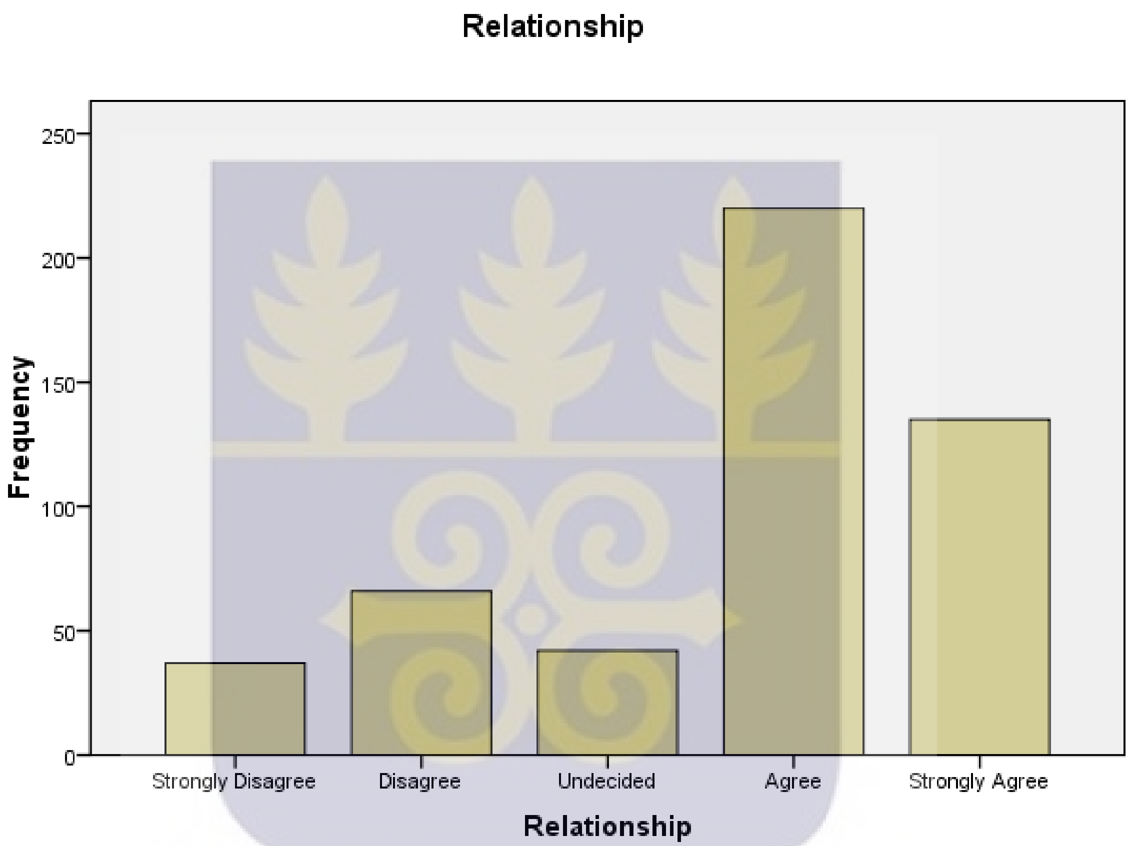

FIGURE 5: Distribution of Close relations (eg. friends, family) who use the same network.

The bar graph of figure 5 shows that the relationship with other people influences one's choice of the mobile phone network, since the greater proportion (71.0%) agreed. This means an individual would choose a particular network if a lover, family or friend uses same network. But 20.6% disagreed with this attribute.

4.4.6 The Bar Graph of Fast Internet Speed

Figure 6 (obtained from Table C6 of Appendix II) shows the bar graph of the fast internet speed.

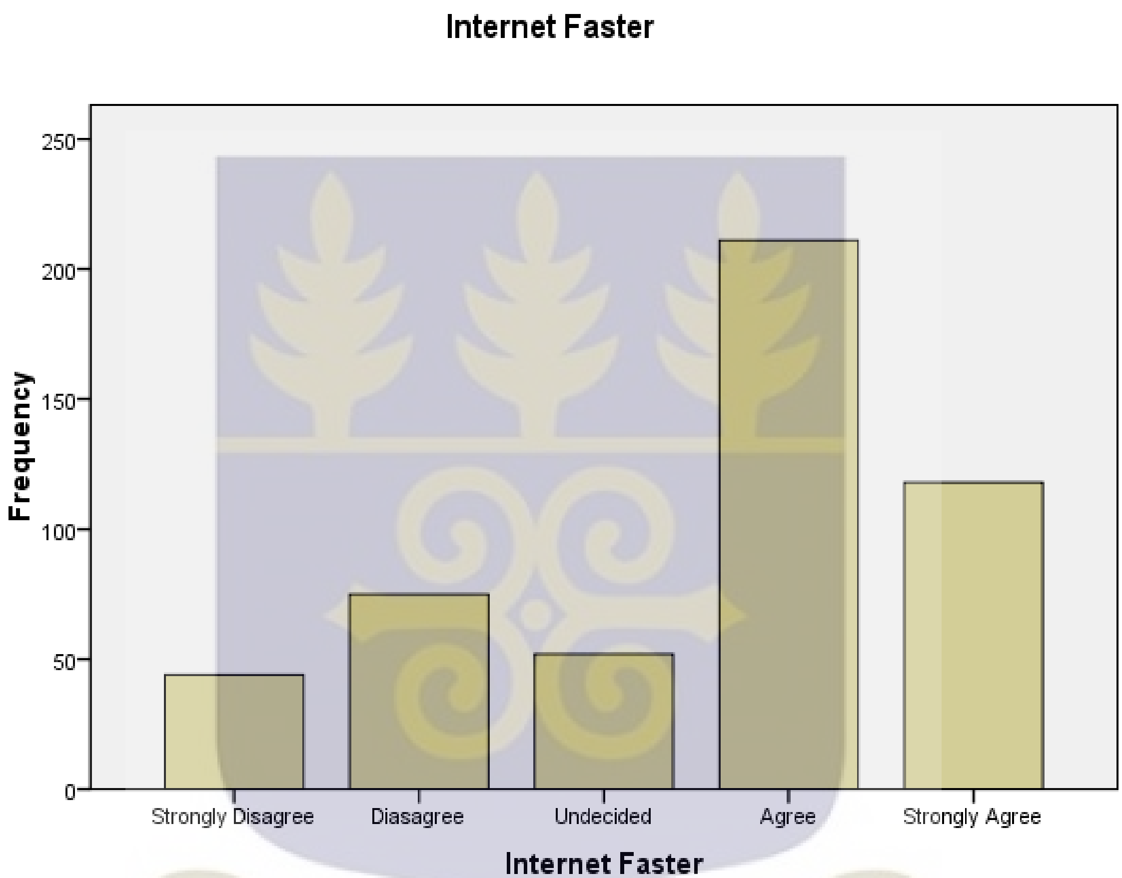

FIGURE 6: Distribution of fast Internet Speed.

It is clear from figure 6 that subscribers (65.8%) look for fast Internet speed before making a choice. There is no doubt that an individual would choose a network that has faster internet speed, because, internet technology plays a vital role in both information delivery and retrieval especially in e-learning, e-commerce and e-banking. 20.8% said they would not consider the internet speed in selecting a network to use.

4.4.7 The Bar Graph of Cheaper Starter Pack

Figure 7 shows the bar graph of Cheaper Starter Pack obtained from Table C7 of Appendix II.

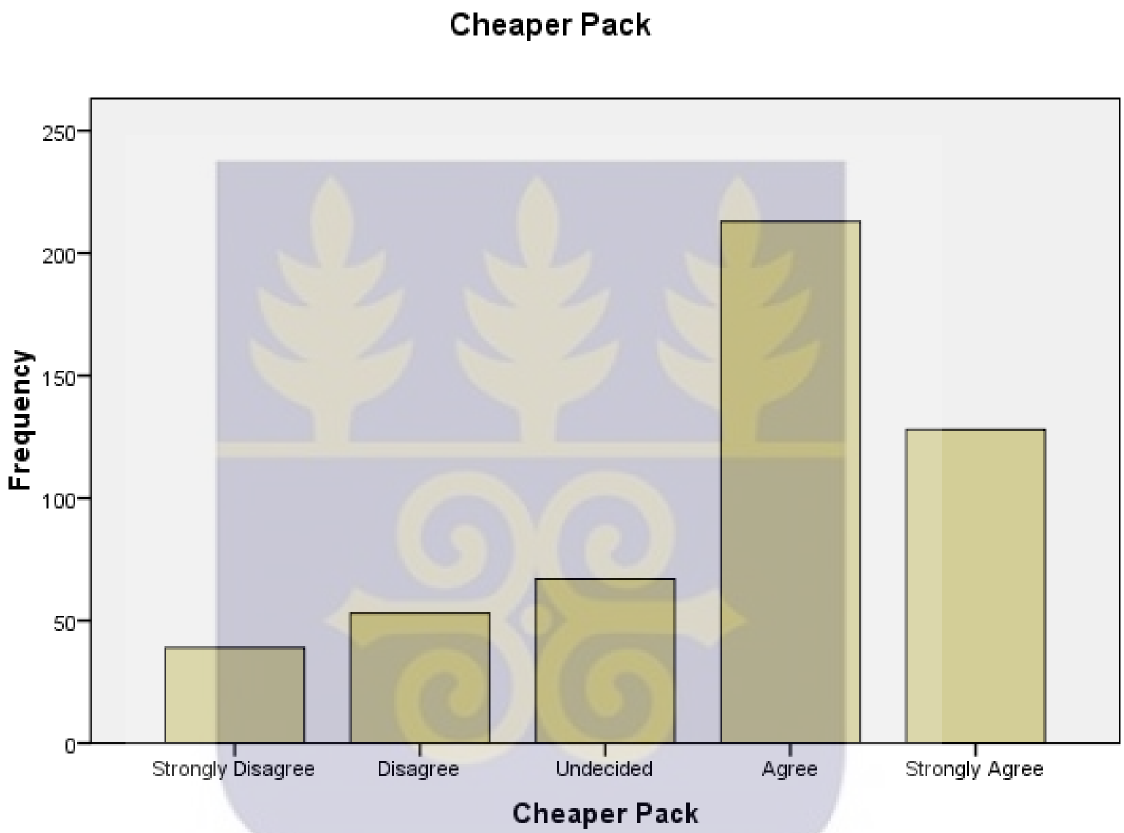

FIGURE 7: Distribution of Cheaper starter pack.

From Figure 7, the majority (68.2%) of the respondents said, there is no way that they will buy a chip that is very expensive. Thus, a new customer would definitely choose a network that has cheaper starter pack. But some (18.4%) respondents said they would not consider the price of the starter pack before becoming subscribers, while 13.4% of the respondents neither agreed nor disagreed to this network attribute.

4.4.8 The Bar Graph of Strong Network in my Area

Figure 8 shows the bar graph of the strong area network obtained from Table C8 of Appendix II.

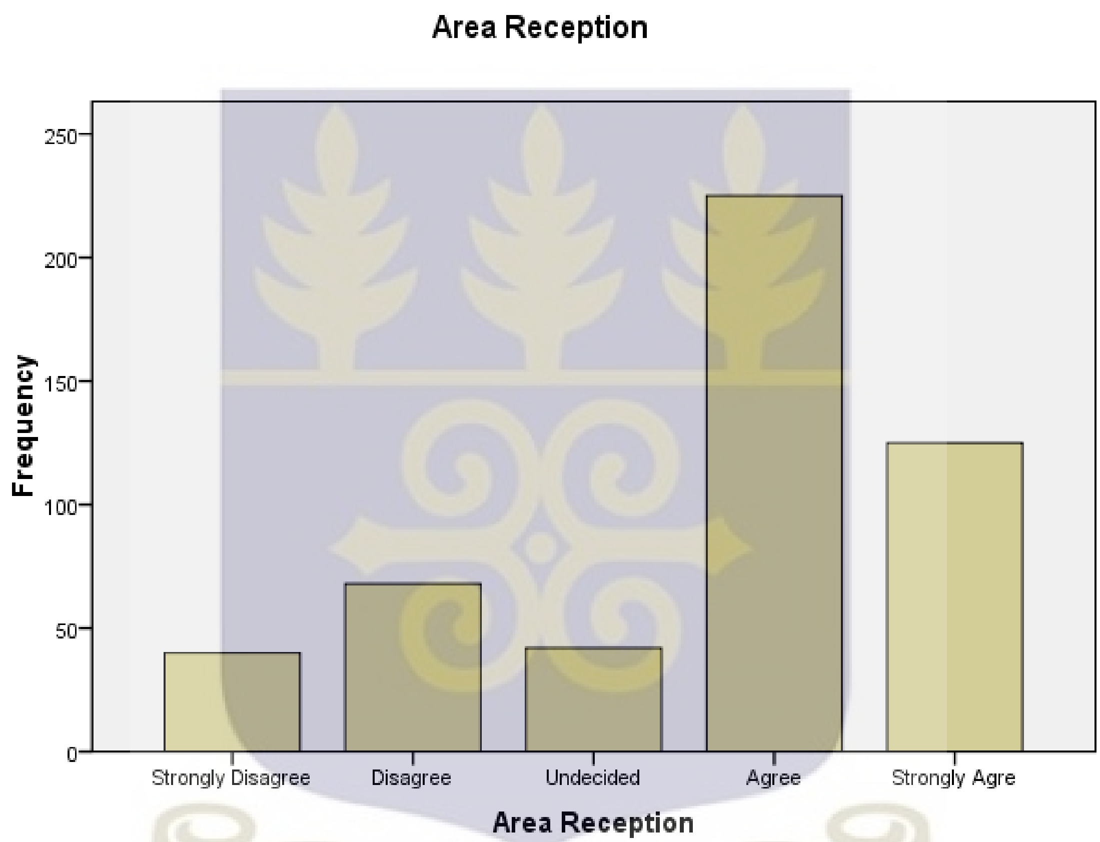

FIGURE 8: Distribution of strong network in my area.

It is clear from figure 8 that, most of the respondents (70.0%) agree that they would choose a network that has strong reception in their area. This is shown by the two highest bars in the graph. But 21.6% of the respondents disagree that strong area reception would influence them in choosing a network.

4.4.9 The Bar Graph of Mobile Phone Banking Services

Figure 9 (obtained from Table C9 of Appendix II) shows the bar graph of Mobile phone banking services

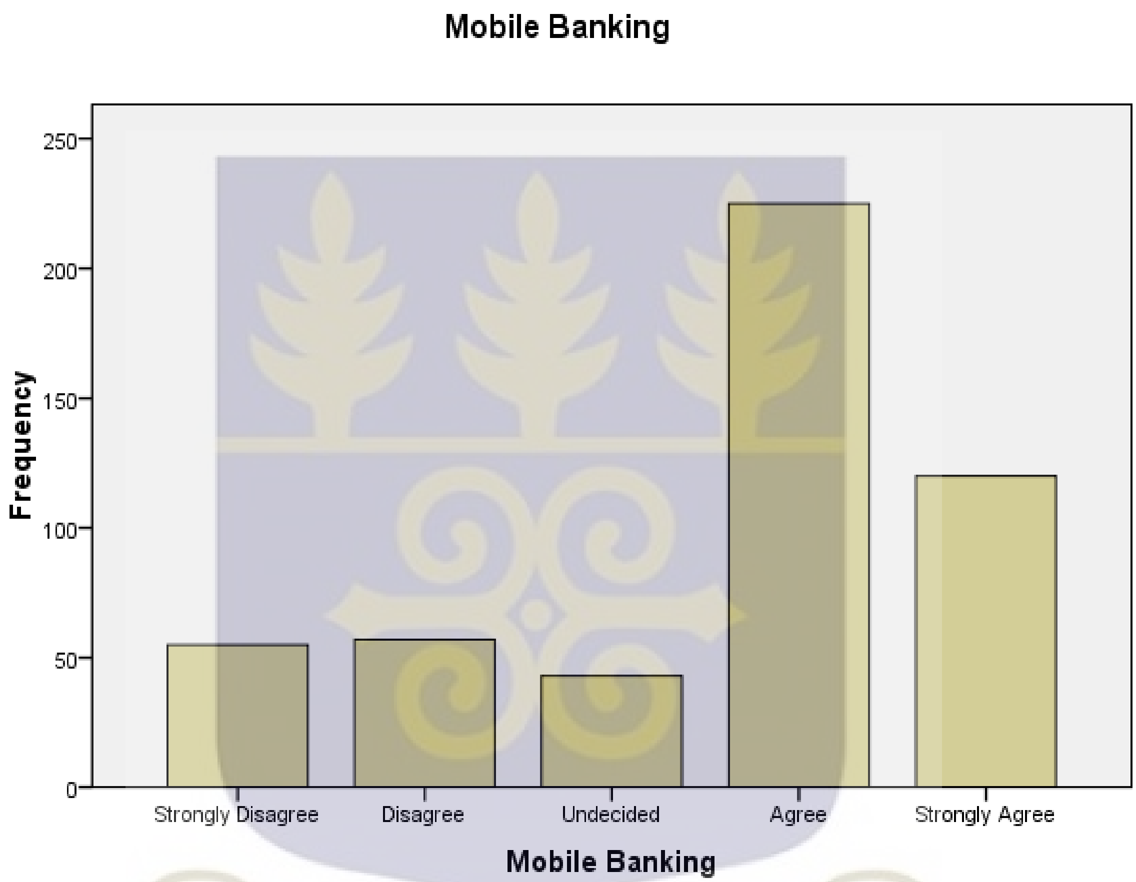

FIGURE 9: Distribution of Mobile Phone Banking service.

The mobile phone banking services MTN mobile money, Tigo cash and Airtel money, operated by MTN, Tigo and Airtel respectively, have gained popularity in our society, since money can be sent and received through mobile phone. There is no doubt that overwhelming majority (69%) of the respondents said their selection of mobile phone network would be influenced by mobile phone banking; this is shown by figure 9. Nowadays, some small and

disagree that games of chance would influence them in any way. However, 19% of the respondents said they are neutral or undecided.

4.4.11 The Bar Graph of the network has Good Advert.

Figure 11 (obtained from Table C11 of Appendix II) shows the bar graph of the Network has Good Advert.

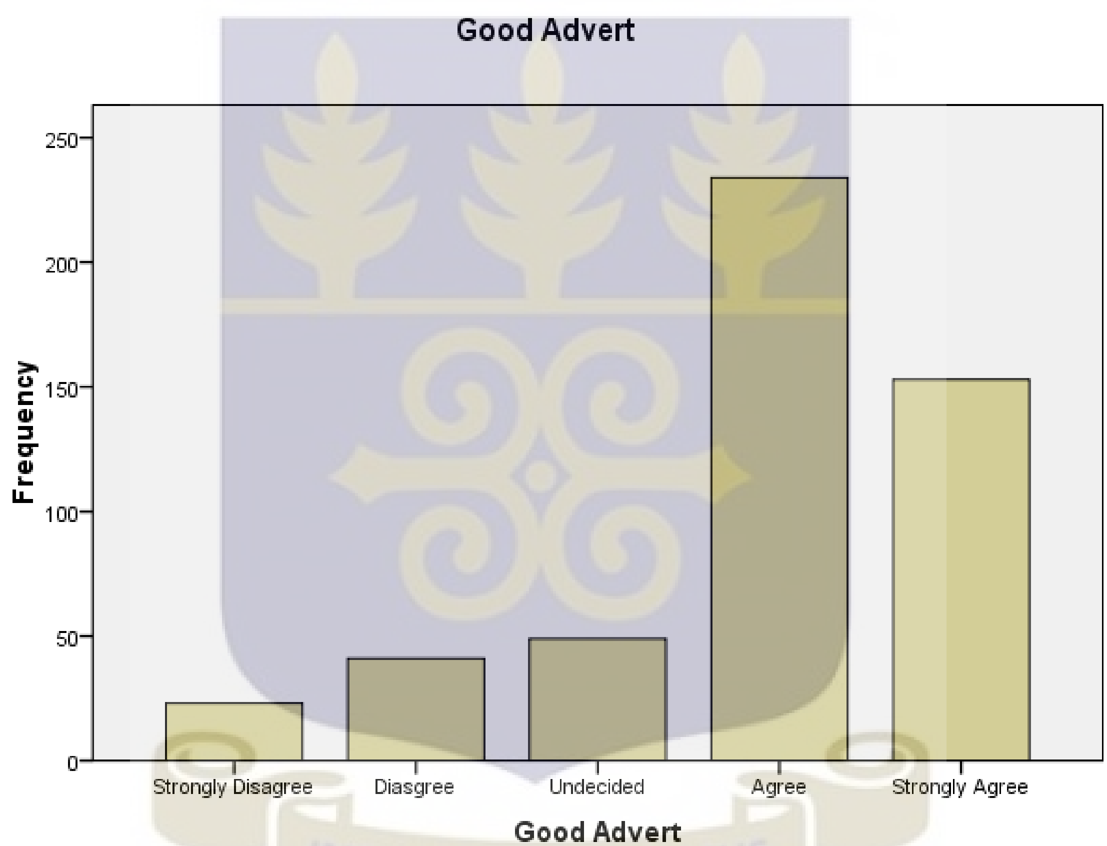

FIGURE 11: Distribution of the network has Good Advert.

It is believed that "good advertisement" (the third most important attribute) plays an important role in marketing, to which the majority (77.0%) of the respondents agreed. Very good advertisement draws public attention to a particular network, especially funny advertisement would have greater influence on the public's choice. But only 12.8% of the

since part of the company's profits, is re-invested in the society it is a good thing to be done. But 20.6% (Figure 13) respondents said they do not think that social or charity work of the operators would persuade them to choose a particular network.

4.4.14 The Bar Graph of long Time usage of a Network

Figure 14 shows the bar graph of long time usage of a network obtained from Table C14 of Appendix II.

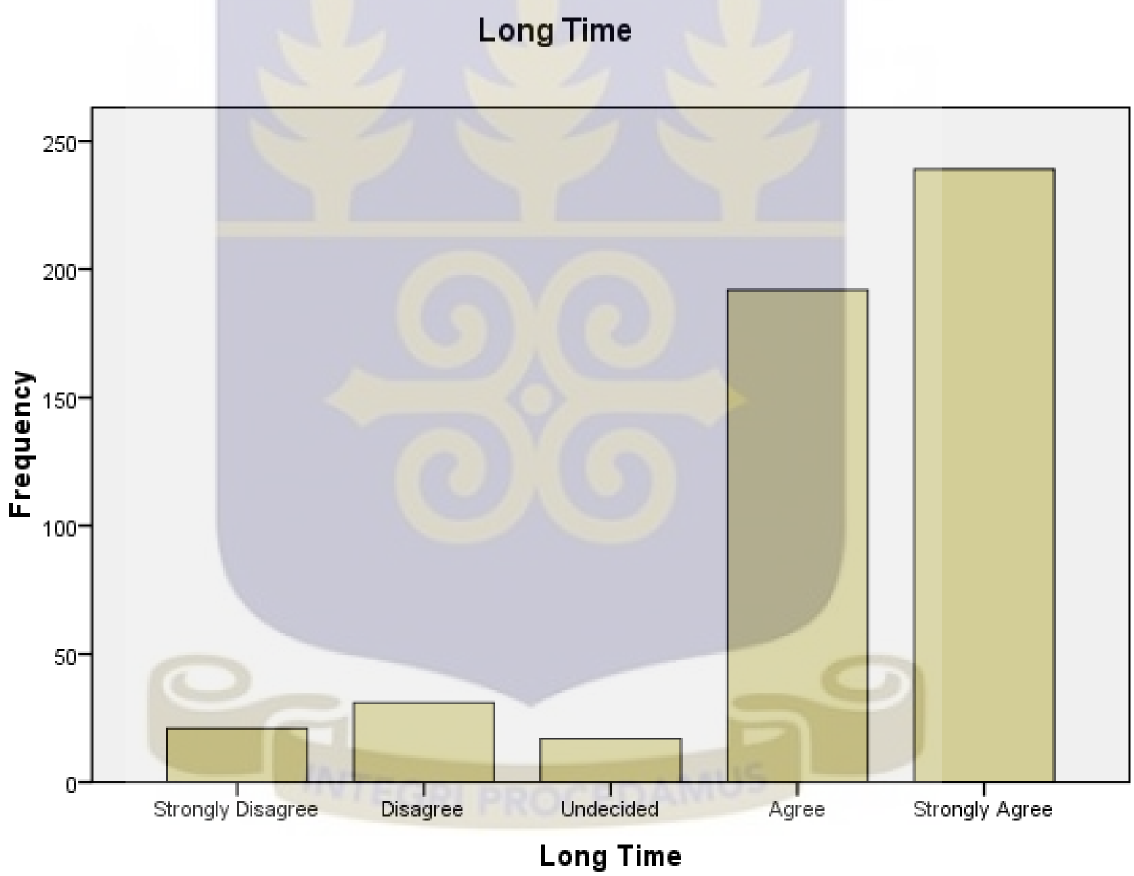

FIGURE 14: Distribution of Long time usage of a network.

Surprisingly, the vast majority 86.2% (Figure 14 obtained from Table C14 of Appendix II) of the respondents said since they have used a particular network for a "long time" (the most influential attribute) it would be very difficult to change over for another network. That is why the new operators (Airtel, Glo and Expresso) are finding it difficult to penetrate the network subscription market. But 10.4% of the respondents said they can easily switch to another network even if they have used the network for a long time.

4.5 CORRELATION MATRIX OF THE VARIABLES (MOBILE PHONE ATTRIBUTES)

Table 4.5 shows the correlation matrix of the mobile phone attributes(variables) obtained from Table F1 of Appendix II.

Table 4.5: Correlation Matrix.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_1	1.000													
X_2	**.444**	1.000												
X_3	.111	.320	1.000											
X_4	.204	.343	**.445**	1.000										
X_5	.239	.288	.180	.368	1.000									
X_6	.310	**.478**	.343	.333	.248	1.000								
X_7	.304	.293	.347	.390	.289	.412	1.000							
X_8	.335	**.432**	.245	.355	.394	.397	.215	1.000						
X_9	.239	.253	.056*	.222	.256	.222	.228	.344	1.000					
X_{10}	.170	.269	.330	**.456**	.349	.296	.286	.317	.298	1.000				
X_{11}	.198	.298	.301	.304	.290	.325	**.420**	.303	.241	.387	1.000			
X_{12}	.190	.222	.289	.379	.314	.340	.262	.333	.257	**.402**	.295	1.000		
X_{13}	.161	.283	.309	.390	.300	.366	.366	.331	.193	.308	.385	**.484**	1.000	
X_{14}	.305	.276	.102*	.232	.264	.264	.298	.294	.281	.192	.284	.318	.350	1.000

*Value not significant at 0.05

The correlation matrix of the data obtained to understand the attributes of mobile phone network is shown in Table 4.5 (obtained from Table F1 of Appendix II). Surprisingly, there are relatively low positive correlations among all the mobile phone attributes ranging from $0.111 \; to \; 0.484$. The lowest correlation (0.111) is between X_1 (has wider coverage) against X_3 (cheaper call cost). This convinces us that a network that has wider coverage is not necessarily cheap or a network that is cheap does not mean it has wider coverage.

Moreover, the highest correlation (0.484) is found between X_{12} (regular sponsorship of national events, eg. football) and X_{13} (encouraging charity work). It is not surprising that these two mobile phone attributes have relatively high correlation as compared to others, this means, social responsibility of the network operator influences one's choice of that particular network. This is because during these activities (events) adverts are made and it creates awareness so that when one wants to purchase a network, that particular network would be most appealing. This is confirmed by the bar graphs shown in Figure 12 and 13.

The null hypothesis, H_0 that the population correlation matrix is an identity matrix or the variables are uncorrelated $(r = 0)$- is rejected by Bartlett's test of sphericity. Since there are correlations (though, low positive correlations) among the mobile phone attributes, then there is a strong reason for factoring or factor analysis is an appropriate technique for the analysis.

4.6 TEST OF RELIABILITY (OR CONSISTENCY)

Table 4.6 (obtained from Table E1 of Appendix II) shows the test of internal reliability (consistency) of the data.

Table 4.6: Test of reliability (or consistency) of the collected data.

Cronbach's alpha	Number of items
.857	14

The Table 4.6 gave Cronbach's alpha (coefficient) of 0.857 (Table E1 of Appendix II) which is greater than 0.700 (Nunnally, 1978). This means the data collected from the respondents is reliable (consistent) and can be used for the analysis.

4.7 KAISER-MEYER-OLKIN (KMO) AND BARTLETT'S TEST.

Table 4.7 (obtained from Table E2 of Appendix II) shows the test values of Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of sphericity.

Table 4.7: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test.

Test	Value
Kaiser-Meyer-Olkin (KMO)	0.887
Bartlett's Test of Sphericity	1918.0
Degrees of freedom	91
Significance	0.000

The Table 4.7 shows Kaiser-Meyer-Olkin (KMO) value of 0.887 (from Table 4.7) which is very close to 0.90, is large (that is > 0.5), we therefore say that the data is very adequate for factoring.

This indicates that correlations between pairs of variables (mobile phone attributes) can be explained by other variables (mobile phone attributes) and that, factor analysis is appropriate and correlation matrix is appropriate for factoring (Kaiser & Rice, 1974).

Moreover, the Bartlett's test of sphericity is also highly significant with p-value of 0.000 at relatively high chi-square value of 1918.00. These tests suggest that factor analysis is appropriate for the data

B. FURTHER ANALYSIS

This section concerns further analysis of the data collected from Cape Coast Polytechnic population. The factor analysis being the main statistical technique used in this research, is to find the underlying (latent) few factors that summarize the fourteen set of variables (mobile phone attributes).

It was seen in the previous section that most of the variables are positively correlated and preliminary analysis generally revealed that factor analysis is suitable for the data as indicated by Bartlett's tests of sphericity and KMO value of sample adequacy. There is therefore the need to further investigate to identify the groupings (factors) among the attributes (variables) that influence subscribers' choice of mobile phone network.

4.8 NUMBER OF FACTORS TO EXTRACT

In this section eigenvalues and scree plot is used to determine the number of factors that best summarizes the data.

4.8.1 Use of Eigen Value Analysis.

In this, eigenvalues greater- than- one rule is used to determine the number of factors (component) to be extracted or retained (Zwich & Velicer, 1986; Cliff, 1988).

Table 4.8 (obtained from Table G1 of Appendix) shows the eigenvalues (total variation explained) by the mobile phone attributes.

Table 4.8: Total Variance Explained.

Component	Eigenvalues	% of variance
1	4.948	35.35
2	1.251	8.94
3	1.064	7.60
4	0.927	6.62
5	0.820	5.86
6	0.737	5.27
7	0.680	4.86
8	0.623	4.45
9	0.608	4.35
10	0.539	3.85
11	0.507	3.62
12	0.489	3.49
13	0.423	3.02
14	0.381	2.72

The Table 4.8 (obtained from Table G1 of Appendix II) indicates the eigenvalues and percentage of variation explained by all the fourteen indicator variables (mobile phone attributes). It is clear from Table 4.8 that only three (3) components (mobile phone attributes) out of the original fourteen (14) components (mobile phone attributes) have eigenvalues $\lambda_1 = 4.948$, $\lambda_2 = 1.251$ and $\lambda_3 = 1.064$ significantly greater than one (Table 4.8). This suggests that three factors can be extracted.

4.8.2 Scree Plot

Figure 15 shows a scree plot (a plot of eigenvalues against corresponding components number) obtained from Table G1 of Appendix II.

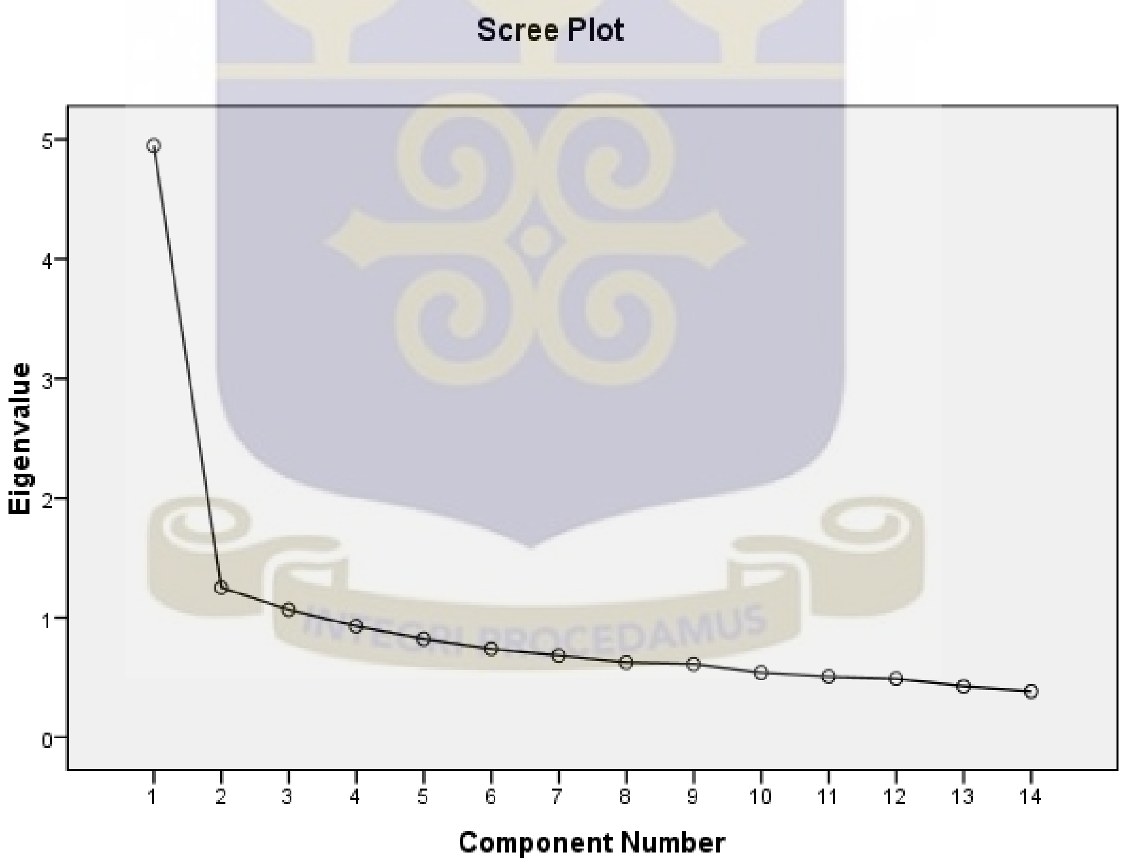

Figure 15: Scree plot of eigenvalues and components.

From the scree plot (figure 15), it can be seen that a distinct break occurs at the second component (factor), that is where an ‘elbow’ of the diagram is shown. Moreover, from the second component (factor) on, we can see that the line is almost flat (uniform) meaning each successive factor is accounting for smaller and smaller amounts of the total variation. This pre-supposes that two factors can be considered for extraction. In all, the maximum number of factors that best explain the data set must not exceed three.

4.9 REPRODUCE CORRELATION MATRIX

Table 4.9 shows the Reproduced Correlation Matrix and Residuals of the variables (mobile phone attributes) obtained from Table F2 of Appendix II.

Table 4.9: Reproduce correlation matrix.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_1	.640*													
X_2	.595	.659*												
X_3	.093	.350	.676*											
X_4	.159	.337	.515	.539*										
X_5	.269	.249	.164	.353	.408*									
X_6	.450	.572	.454	.426	.285	.550*								
X_7	.303	.445	.462	.449	.291	.470	.437*							
X_8	.449	.462	.193	.345	.400	.417	.359	.483*						
X_9	.326	.241	-.084	.191	.404	.192	.171	.418	.513*					
X_{10}	.086	.212	.369	.485	.395	.308	.361	.335	.282	.499*				
X_{11}	.205	.322	.379	.450	.352	.375	.384	.355	.252	.423	.395*			
X_{12}	.095	.187	.291	.463	.433	.274	.331	.361	.355	.509	.420	.537*		
X_{13}	.137	.263	.385	.491	.397	.346	.384	.359	.287	.492	.431	.498	.490*	
X_{14}	.366	.321	.025	.244	.391	.274	.239	.432	.462	.294	.284	.346	.306	.438*
X_1														
X_2	-.152													
X_3	.018	-.029												
X_4	.045	.006	-.070											
X_5	-.006	.018	.016	.016										
X_6	-.140	-.094	-.111	-.093	-.037									
X_7	.000	-.152	-.114	-.059	-.002	-.058								
X_8	-.114	-.030	.052	.011	-.006	-.020	.057							
X_9	-.087	.012	.139	.032	-.148	.030	-.075	-.074						
X_{10}	.084	.056	-.039	-.029	-.046	-.012	.036	-.018	.016					
X_{11}	-.007	-.024	-.078	-.145	-.061	-.050	-.069	-.052	-.011	-.036				
X_{12}	.095	.035	-.002	-.084	-.119	.066	-.018	-.028	-.098	-.107	-.125			
X_{13}	.024	.020	-.078	-.101	-.097	.020	-.018	-.028	-.093	-.184	-.046	-.014		
X_{14}	-.062	-.046	.078	-.012	-.127	-.011	.059	-.138	-.181	-.101	.000	-.028	.044	

Table 4.9 contains two tables, the reproduced correlation matrix in the top part of the table, the diagonal values in the reproduced matrix (indicated by *), is the communalities; and the residuals (the differences between the observed correlations and the reproduced correlations), in the bottom part of the table for the fourteen (14) mobile phone attributes.

From the table, the values of the reproduced matrix are close to the values in the original correlation matrix, or residual matrix is close to zero. Since the reproduce matrix is very similar to the observed correlation matrix, then the three factors that were extracted accounted for a great deal of the variance in the original (observed) correlation matrix. Thus, these few (three) factors do a good job of representing the original data.

4.10 UN-ROTATED FACTOR (COMPONENT) MATRIX

Table 4.10 (obtained from Table G3 of Appendix II) shows the Un-rotated component (factor) matrix of the variables.

Table 4.10: Un-rotated Component Matrix.

Variable	Factor 1	Factor 2	Factor 3
X_1	.490	**.563**	-.288
X_2	**.628**	.296	-.420
X_3	**.530**	-.494	-.389
X_4	**.665**	-.309	-.026
X_5	**.575**	.073	.269
X_6	**.652**	.055	-.348
X_7	**.618**	-.107	-.209
X_8	**.642**	.263	.045
X_9	.473	.368	.393
X_{10}	**.614**	-.265	.226
X_{11}	**.610**	-.145	.043
X_{12}	**.618**	-.194	.342
X_{13}	**.640**	-.226	.171
X_{14}	**.525**	.320	.246

4.11 VARIMAX ROTATED COMPONENT (FACTOR) MATRIX

Table 4.11 (obtained from Table G4 of Appendix II) shows the Varimax Rotated Component (Factor) Matrix

Table 4.11: Varimax Rotated Component Matrix.

Variable	Factor 1	Factor 2	Factor 3
X_1	- .055	**.735**	.312
X_2	.232	**.763**	.154
X_3	**.724**	.291	-.259
X_4	**.688**	.200	.159
X_5	.353	.142	**.513**
X_6	.421	**.602**	.100
X_7	**.511**	.407	.103
X_8	.266	.428	**.478**
X_9	.072	.154	**.696**
X_{10}	**.621**	.022	.336
X_{11}	**.533**	.208	.261
X_{12}	**.573**	-.021	.455
X_{13}	**.611**	.093	.328
X_{14}	.143	.258	**.593**

Considering the un-rotated factor matrix in table 4.10, and using a cut-off loading value of 0.5, you can see that there are high loadings for almost all the mobile phone attributes on factor one with exception of X_8 (strong coverage in my area) and X_9 (mobile phone banking), whereas only one attribute X_8 (strong coverage in my area) loads high on factor two. It is interesting to note that since no attribute has high loading on factor three (3) this makes the interpretation of the factors very difficult.

4.11.1 Factor Rotation

To determine the number of components that need to be retained we follow the rules of the "elbow" of the scree plot and eigenvalue-greater-than-one (Cliff, 1988). These rules suggest a maximum of three (3) factors. The varimax rotated factor structure of Table 4.11 is used for easy interpretation. Notice that the mobile phone attributes (indicators) can be written as a function of three common factors and fourteen (14) unique factors by:

$$X_1 = -0.055 f_1 + 0.735 f_2 + 0.312 f_3 + \varepsilon_1$$

$$X_2 = 0.232 f_1 + 0.763 f_2 + 0.154 f_3 + \varepsilon_2$$

$$\vdots \qquad \vdots \qquad \vdots$$

$$X_{14} = 0.143 f_1 + 0.258 f_2 + 0.593 f_3 + \varepsilon_{14}$$

The above equations can be written in the form $\mathbf{X} = \mathbf{LF} + \boldsymbol{\varepsilon}$ defined in equation 3.1. It can be seen from Table 4.8 that the variances accounted for by the three (3) factors f_1, f_2 and f_3 are $\lambda_1 = 4.948$, $\lambda_2 = 1.251$ and $\lambda_3 = 1.064$ respectively. The total amount of correlation among the indicators (mobile phone attributes) explained by the three factors is $7.263(= 4.948 + 1.251 + 1.064)$ which constitute 52.0% (from Table G1 of Appendix II) of the total variation. The unique variance ε accounts for the remaining 48.0%.

The varimax rotated factor pattern of Table 4.11, proposed by Kaiser (1958) form the basis for easy interpretation of the factors. It is important to note that the factor rotation does not change the underlying solution.

It can be seen from Table 5.4 that **factor 1** has high coefficients (correlations or loadings) for attributes X_3 (lower tariff), X_4 (motivation), X_7 (cheaper starter pack), X_{10} (organizes games of chance), X_{11} (has good advert), X_{12} (sponsorship of national events eg. football) and X_{13} (charity work), this factor can be labeled as ***social responsibility factor*** or ***customer benefit (care) factor***.

Thus, subscribers consider the reward schemes that the network operators can offer him or her and the society before choosing a particular network. It is convincing that a sports fan would definitely go in for a network operator that sponsors sports (football matches). Also, there is no doubt that an entertainment (music and dance) fan would choose a network that sponsors entertainment.

It is interesting that **factor 2** has high loadings or correlation on the attributes X_1 (has wider coverage), X_2 (has reliable network) and X_6 (faster internet speed), this factor can be termed, ***reception benefit factor***. There is no doubt that potential subscribers look for quality network before making a choice.

Finally, **factor 3** has high coefficients or loadings (correlation) for attributes X_5 (close relations use same network), X_9 (mobile phone banking) and X_{14} (used for long time) but the variable X_8 (strong reception in my area), which is marginally low (slightly lower than 0.500) can be considered in factor three, therefore this factor may be labeled ***relationship benefit factor***. It is convincing that subscribers choose network which has direct relation or benefit from his or her relationship with people he or she knows.

4.11.2 Final Factor Solution

The solution obtained from the rotated factor matrix which gives us the final latent factors that best explain the variation in the choice of mobile phone network of the Cape Coast Polytechnic population. Notice that, the varimax transformation matrix is critical in determining the order of importance of the factors.

From all the analysis carried out, it is clear that, the three (3) factor solution is appropriate and adequate in explaining the differences that exist in the choice of mobile phone network of the people of Cape Coast Polytechnics. The first factor is the ***social responsibility factor*** (or ***customer care factor***) of the people, the next is the ***reception benefit factor***, whilst the last factor is the ***relationship benefit factor.*** These three (3) factors identified, best summarize the people's choice of mobile phone network in Cape Coast Polytechnic.

4.12 ESTIMATING FACTOR SCORE

Using Table G6 of Appendix II, component or factor score matrix of the mobile phone attributes, factor score can be estimated (using equation 3.16) as:

$$f_1 = (-.250) + (-.079) + (.356) + \ldots + (.198) + (.219) + (-.107) = 1.066$$

$$f_2 = (.466) + (.459) + (.109) + \ldots + (-.238) + (-.137) + (.022) = .897$$

$$f_3 = (.075) + (-.105) + (-.403) + \ldots + (.216) + (.090) + (.344) = .940$$

From the estimated factor score above it is interesting to note that factor one (social responsibility or customer care factor) had the highest score (1.066), factor three (relationship benefit factor) recorded the next highest score (0.940), while factor two (reception benefit factor) recorded the least score (0.896). This means that the respondents considered "social responsibility or customer care factor" very important or influential followed by the "relationship benefit factor", while "reception benefit factor" is the least important or influential by Cape Coast Polytechnic population.

In follow-up analysis (further analysis) these estimated factor scores can be used in regression analysis as well as analysis of variance (ANOVA).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 INTRODUCTION

The results of the research are clearly stated and explained in this Chapter. The findings are summarized, while conclusions and recommendations are made. Suggestions for further studies are also embodied in this chapter.

5.1 SUMMARY OF FINDINGS

Discoveries from this research were made based on the empirical analysis made in the previous chapter. Some of these findings are in line with other people's studies similar to mine. The research findings are enumerated as follows:

1. The respondents consider "long time usage" very important (from Table 4.2) since this attribute had the highest rating (with highest mean of 4.19), while "wider coverage" and "good advert" are considered the second most important attributes.
2. These attributes "lower tariff" and "games of chance" having means 3.29 and 3.22 (from Table 4.2) respectively, were considered as less important by the respondents.
3. The three most regularly used mobile phone network by Cape Coast Polytechnic population are MTN (60.6%), Tigo (32.8%) and Vodafone (17.2%) from Table 4.4. But Airtel and Globacom, recorded 11.6% and 8.0% respectively of the market share in Cape Coast Polytechnic, while the least patronized network is Expresso with 2.6% of the respondents (from Table 4.4). Notice that, due to multiple subscriptions, the sum of the percentages of the most regularly used networks would be more than 100.
4. The lowest correlation (0.111), from Table 4.5, is between X_1 (wider coverage) against X_3 (lower tariff). This tells us that a network that has wider coverage is not

necessarily cheap or a network that is cheap does not mean it has wider coverage. Whilst the highest correlation (0.484), from Table 4.5, is found against X_{12} (regular sponsorship of national events. eg. football) and X_{13} (encouraging charity work). It is not surprising that these two mobile phone attributes have high correlation as compared to others, this means, social responsibility of the network operator influences one's choice of mobile phone network.

5. In all, three (3) factors were extracted, **factor one** (***social responsibility factor*** or ***customer care factor***), the next is **factor two** (***reception benefit factor***) and **factor three** is the ***relationship benefit factor*** of the people in Cape Coast Polytechnic.
6. The respondents considered "social responsibility or customer care factor" the most influential or important, followed by "relationship benefit factor", while the "reception benefit factor" is the third important factor.
7. The total amount of correlation among the mobile phone attributes and the three factors extracted is $7.263\left(=4.948+1.251+1.064,\ \textit{Table}\ 4.8\right)$ which constitute 52.0% of the total variation explained while the remaining 48.0% of the total variation is unexplained (that is the unique variance ε accounts for 48%).

5.2 DISCUSSION OF FINDINGS

It is convincing to recognize that "long time usage" is the most important (86.2%, from Figure 14) attribute that the subscribers consider. It is true that a subscriber who has used a particular network for a very long time finds it very difficult to change over since most of his/her relations would miss him/her. The next most important attribute is "wider coverage" this is convincing that potential customers look for a network that has nationwide coverage (81.4%, from Figure 1), while "good advert" is the third most important attribute. It is believed that good and constant advertisement draws potential subscriber's attention to that network.

The respondents consider "games of chance" as less important (49%, from Figure 10). The respondents foresee that lucky games (lotteries) organized by the network operators do not influence them in their choice of mobile phone network.

The MTN which has largest market share as announced by the National Communication Authority (May 2015) in the country's Daily Graphic, still continues to enjoy that privilege in Cape Coast Polytechnic. Vodafone has the third market share after Tigo in the study area.

These two mobile phone operators (MTN and Tigo) that have the largest market share in Cape Coast Polytechnic operate mobile money services-MTN mobile money and Tigo Cash. This might be the reason why MTN and Tigo have overtaken Vodafone (formerly Onetouch) in terms of market share. It will not be surprising if Airtel (which provides Airtel money services) overtake Vodafone in the near future. This is a wake-up call for the network providers who are not in mobile money banking services to do so. Expresso which has the least market share in the study area, operates analog services, that is subscribers do not use chip and one has no chance of changing the phone once they have bought analog phone. I believe that if they continue with this service their already existing subscribers might change for other networks.

Though, correlations among the mobile phone attributes are low, the highest correlation is found between "regular sponsorship of national events, eg. football" and "encouraging charity work". It is not surprising that these two mobile phone attributes have a high positive correlation as compared to others. This means, social responsibility of the network operator influences one's choice of mobile phone network. The lowest positive correlation recorded between "wider coverage" and "cheaper call cost" indicate that a network that has wider coverage is not necessarily cheap or a network that is cheap does not mean it has wider coverage.

The three (3) factors that summarize the data showed that subscribers consider "social responsibility or customer care factor" (which talks about what the operators are doing for its customers and the nation at large) is considered the most important or influential by the respondents**.** It is convincing that what mobile phone operators are doing for the society is having a positive impact on the people of Cape Coast Polytechnic.

The "relationship benefit factor" (which talks about the relationship with other people) is the next most important or influential factor. It is not surprising that very good friends, business partners and family members use the same network since the reward schemes and promotions (free calls to the same network) would be enjoyed by them. Thus, the relationship with other people influences one's choice of mobile phone network by the people in Cape Coast Polytechnic.

The "reception benefit factor" is considered the third important or influential factor when making a choice. This is drawing our attention to the fact that "wider coverage", "reliability" and "fast internet speed" of a network are not all that important when it comes to the choice of mobile phone network.

5.3 CONCLUSION AND RECOMMENDATIONS

In conclusion, respondents who decided to subscribe to MTN network considered "wider coverage" as their most important attribute.

Secondly, the respondents also consider "good advert" as their next most important attribute when it comes to subscription of a network.

Moreover, majority of the respondents considered "mobile money services" as their third most important attribute that lure them in choosing MTN and Tigo network. The least important (or influential) attribute is "games of chance".

Furthermore, respondents consider "social responsibility or customer care" as the most important and "reception benefit" of the network operator as the least important factor when choosing a network.

Based on the findings, the network operators (MTN, Vodafone, Tigo, Airtel, Globacom and Expresso) should consider the following recommendations:

1. The network operators should increase their coverage area to increase catchment area to attract more potential subscribers, since wider coverage is considered as one of the most important attributes.
2. It is worth noting that good advert plays an important role in marketing. Thus, the operators should modify their advertisement, where necessary, to draw attention or attract more potential subscribers.
3. It was revealed in the analysis that subscribers consider firstly, the social or corporate responsibility of the network operator before making a choice. Thus, the operator

should intensify their social and corporate responsibilities (charity work, etc.) to attract more potential subscribers.

4. The respondents are of the view that the analog mobile phone, deter them from subscribing that particular network (eg. Expresso network). Thus, those operators especially Expresso should change from operating analog services.
5. The respondents in the study area said they have accepted mobile phone banking as their means of monetary transaction. It is therefore recommended that, those network operators who are providing this service should improve it, and those who are not providing the mobile money services should do so to increase their market share.

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APPENDIX I

METHODIST UNIVERSITY COLLEGE GHANA

DEPARTMENT OF MATHEMATICAL SCIENCES

QUESTIONNAIRE

QUESTIONNAIRE ON MOBILE PHONE NETWORK PREFERENCE STUDY

The objective of this questionnaire is to determine the underlying factors that influence the customer's choice of a mobile phone network.

The information that will be provided will be kept confidential.

PART I

Please tick [√] where appropriate

1. Gender		**Code**
Male	[ ]	**1**
Female	[ ]	**2**
2. Age		
Under 18 years	[ ]	**1**
18-24 years	[ ]	**2**
25-29 years	[ ]	**3**
30-39years	[ ]	**4**
Over 39years	[ ]	**5**

3. How many networks are you using now ………………………………………………

4. Please mention them……………………………………………………………………

5. Please, using the table below indicate by ticking **[√]** the mobile phone network you use regularly.

Network Provider	**Most Regularly Used (1)**	**Regularly Used (2)**	**Rarely Used (3)**	**Not in use (4)**	**Not Applicable (5)**
MTN					
VODAFONE					
TIGO					
AIRTEL					
GLO					
EXPRESSO					

PART II

In relation to your choice of mobile phone network in **Part I** indicate your option on each of the following attributes. Please **tick [√]** the appropriate cell in each column.

Attributes of mobile phone network	Strongly Disagree (1)	Disagree (2)	Undecided (3)	Agree (4)	Strongly Agree (5)
X_1. Network has wider coverage.					
X_2. Network is reliable.					
X_3. Lower tariff.					
X_4. Frequent Promotions/Rewarding/ Motivation.					
X_5. Close relations (eg. Friends, Family etc) use same network.					
X_6. Faster internet speed					
X_7. Cheaper starter pack					
X_8. Strong network in my area					
X_9. Mobile Phone Banking services					
X_{10}. Frequently organize games of chance					
X_{11}. Has good adverts					
X_{12}. Regular sponsorship of national events (eg. football)					
X_{13}. Active in charity/social work					
X_{14}.Used for a long time					

Thank you

APPENDIX II

A1

Age * Gen crosstab

Count

		Gen		Total
		Male	Female	
Age	Under 18	15	17	32
	18 -24	198	114	312
	25-29	60	35	95
	30-39	25	17	42
	over 39	10	9	19
Total		308	192	500

A2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Coverage	500	1.00	5.00	3.9920	1.16389	-1.355	.109	1.047	.218
Reliable	500	1.00	5.00	3.5160	1.28103	-.659	.109	-.752	.218
Lower tariff	500	1.00	5.00	3.2900	1.37757	-.356	.109	-1.240	.218
Motivation	500	1.00	5.00	3.4800	1.25569	-.598	.109	-.762	.218
Relationship	500	1.00	5.00	3.7000	1.20869	-.871	.109	-.248	.218
Internet Faster	500	1.00	5.00	3.5680	1.24438	-.710	.109	-.585	.218
Cheaper Pack	500	1.00	5.00	3.6760	1.18905	-.854	.109	-.149	.218
Area Reception	500	1.00	5.00	3.6540	1.21706	-.840	.109	-.324	.218
Mobile Banking	500	1.00	5.00	3.5960	1.26965	-.842	.109	-.407	.218
Games of Chance	500	1.00	5.00	3.2240	1.28262	-.270	.109	-1.058	.218
GoodAdvert	500	1.00	5.00	3.9060	1.06745	-1.132	.109	.784	.218
Sponsorship	500	1.00	5.00	3.6200	1.19266	-.770	.109	-.338	.218
Charity	500	1.00	5.00	3.5720	1.21316	-.703	.109	-.443	.218
Long Time	500	1.00	5.00	4.1940	1.05003	-1.593	.109	2.053	.218
Valid N (listwise)	500								

Frequency Table

B1

MTN

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most Regularly Used	281	56.2	56.2	56.2
	Regularly Used	22	4.4	4.4	60.6
	Rarely Used	28	5.6	5.6	66.2
	Not Used	1	.2	.2	66.4
	N/A	168	33.6	33.6	100.0
	Total	500	100.0	100.0	

B2

Tigo

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most Regularly Used	99	19.8	19.8	19.8
	Regularly Used	65	13.0	13.0	32.8
	Rarely Used	51	10.2	10.2	43.0
	Not Used	7	1.4	1.4	44.2
	N/A	278	55.6	55.6	100.0
	Total	500	100.0	100.0	

B3

Vodafone

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most Regularly Used	35	7.0	7.0	7.0
	Regularly Used	51	10.2	10.2	17.2
	Rarely Used	46	9.2	9.2	26.4
	Not Used	12	2.4	2.4	28.8
	N/A	356	71.2	71.2	100.0
	Total	500	100.0	100.0	

B4

Airtel

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most Regularly Used	30	6.0	6.0	6.0
	Regularly Used	28	5.6	5.6	11.6
	Rarely Used	25	5.0	5.0	16.6
	Not Used	13	2.6	2.6	19.2
	N/A	404	80.8	80.8	100.0
	Total	500	100.0	100.0	

B5

Glo

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most Regularly Used	19	3.8	3.8	3.8
	Regularly Used	21	4.2	4.2	8.0
	Rarely Used	24	4.8	4.8	12.8
	Not Used	15	3.0	3.0	15.8
	N/A	421	84.2	84.2	100.0
	Total	500	100.0	100.0	

B6

Expresso

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Most Regularly Used	7	1.4	1.4	1.4
	Regularly Used	6	1.2	1.2	2.6
	Rarely Used	1	.2	.2	2.8
	Not Used	12	2.4	2.4	5.2
	N/A	474	94.8	94.8	100.0
	Total	500	100.0	100.0	

Frequency Table

C1

Coverage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	37	7.4	7.4	7.4
	Disagree	31	6.2	6.2	13.6
	Undecided	25	5.0	5.0	18.6
	Agree	213	42.6	42.6	61.2
	Strongly Agree	194	38.8	38.8	100.0
	Total	500	100.0	100.0	

C2

Reliable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	50	10.0	10.0	10.0
	Disagree	82	16.4	16.4	26.4
	Undecided	43	8.6	8.6	35.0
	Agree	210	42.0	42.0	77.0
	Strongly Agree	115	23.0	23.0	100.0
	Total	500	100.0	100.0	

C3

Lower tariff

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	69	13.8	13.8	13.8
	Disagree	108	21.6	21.6	35.4
	Undecided	39	7.8	7.8	43.2
	Agree	177	35.4	35.4	78.6
	Strongly Agree	107	21.4	21.4	100.0
	Total	500	100.0	100.0	

C4

Motivation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	47	9.4	9.4	9.4
	Disagree	83	16.6	16.6	26.0
	Undecided	60	12.0	12.0	38.0
	Agree	203	40.6	40.6	78.6
	Strongly agree	107	21.4	21.4	100.0
	Total	500	100.0	100.0	

C5

Relationship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	37	7.4	7.4	7.4
	Disagree	66	13.2	13.2	20.6
	Undecided	42	8.4	8.4	29.0
	Agree	220	44.0	44.0	73.0
	Strongly Agree	135	27.0	27.0	100.0
	Total	500	100.0	100.0	

C6

Internet Faster

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	44	8.8	8.8	8.8
	Disagree	75	15.0	15.0	23.8
	Undecided	52	10.4	10.4	34.2
	Agree	211	42.2	42.2	76.4
	Strongly Agree	118	23.6	23.6	100.0
	Total	500	100.0	100.0	

C7

Cheaper Pack

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	39	7.8	7.8	7.8
	Disagree	53	10.6	10.6	18.4
	Undecided	67	13.4	13.4	31.8
	Agree	213	42.6	42.6	74.4
	Strongly Agree	128	25.6	25.6	100.0
	Total	500	100.0	100.0	

C8

Area Reception

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	40	8.0	8.0	8.0
	Disagree	68	13.6	13.6	21.6
	Undecided	42	8.4	8.4	30.0
	Agree	225	45.0	45.0	75.0
	Strongly Agree	125	25.0	25.0	100.0
	Total	500	100.0	100.0	

C9

Mobile Banking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	55	11.0	11.0	11.0
	Disagree	57	11.4	11.4	22.4
	Undecided	43	8.6	8.6	31.0
	Agree	225	45.0	45.0	76.0
	Strongly Agree	120	24.0	24.0	100.0
	Total	500	100.0	100.0	

C10

Game of Chance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	60	12.0	12.0	12.0
	Disagree	100	20.0	20.0	32.0
	Undecided	95	19.0	19.0	51.0
	Agree	158	31.6	31.6	82.6
	Strongly Agree	87	17.4	17.4	100.0
	Total	500	100.0	100.0	

C11

Good Advert

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	23	4.6	4.6	4.6
	Disagree	41	8.2	8.2	12.8
	Undecided	49	9.8	9.8	22.6
	Agree	234	46.8	46.8	69.4
	Strongly Agree	153	30.6	30.6	100.0
	Total	500	100.0	100.0	

C12

Sponsorship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	38	7.6	7.6	7.6
	Disagree	64	12.8	12.8	20.4
	Undecided	66	13.2	13.2	33.6
	Agree	214	42.8	42.8	76.4
	Strongly Agree	118	23.6	23.6	100.0
	Total	500	100.0	100.0	

C13

Charity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	43	8.6	8.6	8.6
	Disagree	60	12.0	12.0	20.6
	Undecided	82	16.4	16.4	37.0
	Agree	198	39.6	39.6	76.6
	Strongly Agree	117	23.4	23.4	100.0
	Total	500	100.0	100.0	

C14

Long Time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	21	4.2	4.2	4.2
	Disagree	31	6.2	6.2	10.4
	Undecided	17	3.4	3.4	13.8
	Agree	192	38.4	38.4	52.2
	Strongly Agree	239	47.8	47.8	100.0
	Total	500	100.0	100.0	

E1

Reliability Statistics

Cronbach's Alpha	N of Items
.857	14

E2

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.887
Bartlett's Test of Sphericity	Approx. Chi-Square	1.918E3
	d f	91
	Sig.	.000

F1

Correlation Matrix

		Coverage	Reliable	Lower Tariff	Motivation	Relationship	Internet Faster	Cheaper Pack	AreaReception	MobileBanking	GameOf Chance	Good Advert	Sponsorship	Charity	LongTime
Correlation	Coverage	1.000	.444	.111	.204	.239	.310	.302	.335	.239	.170	.198	.190	.161	.305
	Reliable	.444	1.000	.320	.343	.288	.478	.293	.432	.253	.269	.298	.222	.283	.276
	Lower Tariff	.111	.320	1.000	.445	.180	.343	.347	.245	.056	.330	.301	.289	.307	.102
	Motivation	.204	.343	.445	1.000	.368	.333	.390	.355	.222	.456	.304	.379	.390	.232
	Relationship	.239	.288	.180	.368	1.000	.248	.289	.394	.256	.349	.290	.314	.300	.264
	InternetFaster	.310	.478	.343	.333	.248	1.000	.412	.397	.222	.296	.325	.340	.366	.264
	CheaperPack	.302	.293	.347	.390	.289	.412	1.000	.215	.228	.286	.420	.262	.366	.298
	Area Reception	.335	.432	.245	.355	.394	.397	.215	1.000	.344	.317	.303	.333	.331	.294
	Mobile Banking	.239	.253	.056*	.222	.256	.222	.228	.344	1.000	.298	.241	.257	.193	.281
	GameOfChance	.170	.269	.330	.456	.349	.296	.286	.317	.298	1.000	.387	.402	.308	.192
	GoodAdvert	.198	.298	.301	.304	.290	.325	.420	.303	.241	.387	1.000	.295	.385	.284
	Sponsorship	.190	.222	.289	.379	.314	.340	.262	.333	.257	.402	.295	1.000	.484	.318
	Charity	.161	.283	.307	.390	.300	.366	.366	.331	.193	.308	.385	.484	1.000	.350
	LongTime	.305	.276	.102*	.232	.264	.264	.298	.294	.281	.192	.284	.318	.350	1.000

*value not significant at 0.05

F2

Reproduced Correlations

		Coverage	Reliable	Lower Tariff	Motivation	Relationship	Internet Faster	Cheaper Pack	AreaReception	Mobile Banking	Game OfChance	Good Advert	Sponsorship	Charity	LongTime
Reproduced Correlation	Coverage	.640[a]	.595	.093	.159	.245	.450	.303	.449	.326	.086	.205	.095	.137	.366
	Reliable	.595	.659[a]	.350	.337	.269	.572	.445	.462	.241	.212	.322	.187	.263	.321
	Lower Tariff	.093	.350	.676[a]	.515	.164	.454	.462	.193	-.084	.369	.379	.291	.385	.025
	Motivation	.159	.337	.515	.539[a]	.353	.426	.449	.345	.191	.485	.450	.463	.491	.244
	Relationship	.245	.269	.164	.353	.408[a]	.285	.291	.400	.404	.395	.352	.433	.397	.391
	InternetFaster	.450	.572	.454	.426	.285	.550[a]	.470	.417	.192	.308	.375	.274	.346	.274
	CheaperPack	.303	.445	.462	.449	.291	.470	.437[a]	.359	.171	.361	.384	.331	.384	.239
	AreaReception	.449	.462	.193	.345	.400	.417	.359	.483[a]	.418	.335	.355	.361	.359	.432
	MobileBanking	.326	.241	-.084	.191	.404	.192	.171	.418	.513[a]	.282	.252	.355	.287	.462
	GameOfChance	.086	.212	.369	.485	.395	.308	.361	.335	.282	.499[a]	.423	.509	.492	.294
	GoodAdvert	.205	.322	.379	.450	.352	.375	.384	.355	.252	.423	.395[a]	.420	.431	.284

	Sponsorship	.095	.187	.291	.463	.433	.274	.331	.361	.355	.509	.420	.537[a]	.498	.346
	Charity	.137	.263	.385	.491	.397	.346	.384	.359	.287	.492	.431	.498	.490[a]	.306
	LongTime	.366	.321	.025	.244	.391	.274	.239	.432	.462	.294	.284	.346	.306	.438[a]
Residual[b]	Coverage		-.152	.018	.045	-.006	-.140	.000	-.114	-.087	.084	-.007	.095	.024	-.062
	Reliable	-.152		-.029	.006	.018	-.094	-.152	-.030	.012	.056	-.024	.035	.020	-.046
	Lower Tariff	.018	-.029		-.070	.016	-.111	-.114	.052	.139	-.039	-.078	-.002	-.078	.078
	Motivation	.045	.006	-.070		.016	-.093	-.059	.011	.032	-.029	-.145	-.084	-.101	-.012
	Relationship	-.006	.018	.016	.016		-.037	-.002	-.006	-.148	-.046	-.061	-.119	-.097	-.127
	InternetFaster	-.140	-.094	-.111	-.093	-.037		-.058	-.020	.030	-.012	-.050	.066	.020	-.011
	CheaperPack	.000	-.152	-.114	-.059	-.002	-.058		-.145	.057	-.075	.036	-.069	-.018	.059
	AreaReception	-.114	-.030	.052	.011	-.006	-.020	-.145		-.074	-.018	-.052	-.028	-.028	-.138
	MobileBanking	-.087	.012	.139	.032	-.148	.030	.057	-.074		.016	-.011	-.098	-.093	-.181
	GameOfChance	.084	.056	-.039	-.029	-.046	-.012	-.075	-.018	.016		-.036	-.107	-.184	-.101

	GoodAdvert	-.007	-.024	-.078	-.145	-.061	-.050	.036	-.052	-.011	-.036		-.125	-.046	.000
	Sponsorship	.095	.035	-.002	-.084	-.119	.066	-.069	-.028	-.098	-.107	-.125		-.014	-.028
	Charity	.024	.020	-.078	-.101	-.097	.020	-.018	-.028	-.093	-.184	-.046	-.014		.044
	LongTime	-.062	-.046	.078	-.012	-.127	-.011	.059	-.138	-.181	-.101	.000	-.028	.044	

Extraction Method: Principal Component Analysis.

a. Reproduced communalities

b. Residuals are computed between observed and reproduced correlations.
There are 45 (49.0%) non-redundant residuals with absolute values greater than 0.05.

G1

Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.948	35.346	35.346	3.085	22.033	22.033
2	1.251	8.938	44.285	2.121	15.152	37.185
3	1.064	7.602	51.887	2.058	14.702	51.887
4	.927	6.624	58.511			
5	.820	5.859	64.370			
6	.737	5.268	69.638			
7	.680	4.861	74.498			
8	.623	4.447	78.945			
9	.608	4.346	83.292			
10	.539	3.853	87.144			
11	.507	3.621	90.765			
12	.489	3.491	94.256			
13	.423	3.023	97.280			
14	.381	2.720	100.000			

Extraction Method: Principal Component Analysis.

G2

Un-rotated Component Matrix[a]

	Component		
	1	2	3
Coverage	.490	.563	-.288
Reliable	.628	.296	-.420
Lower Tariff	.530	-.494	-.389
Motivation	.665	-.309	-.026
Relationship	.575	.073	.269
InternetFaster	.652	.055	-.348
CheaperPack	.618	-.107	-.209
AreaReception	.642	.263	.045
MobileBanking	.473	.368	.393
GameOfChance	.614	-.265	.226
GoodAdvert	.610	-.145	.043
Sponsorship	.618	-.194	.342
Charity	.640	-.226	.171
LongTime	.525	.320	.246

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

G3

Rotated Component Matrix[a]

	Component		
	1	2	3
Coverage	-.055	.735	.312
Reliable	.232	.763	.154
Lower tariff	.724	.291	-.259
Motivation	.688	.200	.159
Relationship	.353	.142	.513
Internet Faster	.421	.602	.100
Cheaper Pack	.511	.407	.103
Area Reception	.266	.428	.478
Mobile Banking	.072	.154	.696
Game Of Chance	.621	.022	.336
Good Advert	.533	.208	.261
Sponsorship	.573	-.021	.455
Charity	.611	.093	.328
Long Time	.143	.258	.593

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 16 iterations.

G4

Component Transformation Matrix

Component	1	2	3
1	.704	.510	.494
2	-.710	.506	.490
3	.000	-.696	.718

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

G5

Coefficient Matrix[a]

	Component		
	1	2	3
Coverage	.087	.311	-.301
Reliable	.142	.188	-.486
Lower tariff	.145	-.599	-.300
Motivation	.146	-.226	.098
Relationship	.113	.117	.224
InternetFaster	.138	.022	-.322
CheaperPack	.117	-.077	-.108
AreaReception	.129	.216	-.023
MobileBanking	.103	.404	.313
GameOfChance	.140	-.137	.366
GoodAdvert	.091	-.038	.056
Sponsorship	.118	-.066	.298
Charity	.126	-.109	.161
LongTime	.073	.163	.054

Extraction Method: Principal Component Analysis.

a. Coefficients are standardized.

G6

Component Score Coefficient Matrix

	Component		
	1	2	3
Coverage	-.250	.466	.075
Reliable	-.079	.459	-.105
Lower Tariff	.356	.109	-.403
Motivation	.270	-.040	-.072
Relationship	.040	-.088	.268
Internet Faster	.062	.317	-.148
Cheaper Pack	.149	.158	-.121
Area Reception	-.058	.143	.197
Mobile Banking	-.141	-.059	.456
Games of Chance	.238	-.192	.110
Good Advert	.169	-.024	.033
Sponsorship	.198	-.238	.216
Charity	.219	-.137	.090
Long Time	-.107	.022	.344

Extraction Method: Principal Component Analysis. Rotation Method:Varimax with Kaiser Normalization. Factor Scores Method: Regression.